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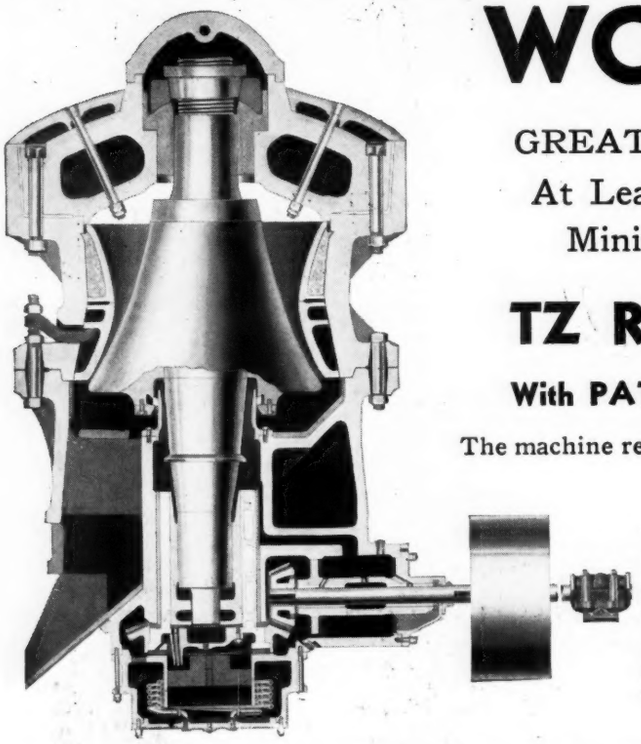

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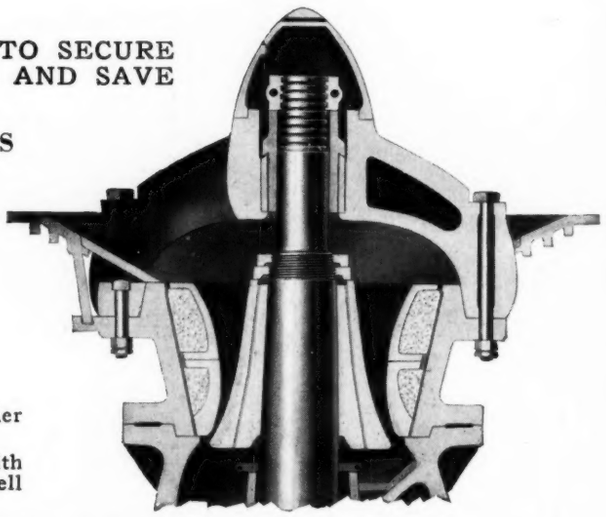

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# Engineering and Mining Journal

*with which is consolidated*

Engineering & Mining World

A. W. ALLEN, *Editor*

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**Engineering & Mining World**

A. W. ALLEN, *Editor*

April, 1932 Vol. 133—No. 4


## Rock Crushing by Gravitational Fall

THE practicability of comminution by utilizing the force developed in the gravitational fall of pieces of rock has long been recognized. Such impact of ore on ore, or ore on metal, has been applied on the Witwatersrand for the crushing of many hundred million tons of material, in conjunction with an abrasive grinding inseparable from the operation of a rotary reduction apparatus of the tube-mill type. Perhaps because of the toughness of some ores, necessitating a heavy blow or high compressive force to effect fracture, no attention has been paid until recently to the opportunity to alter the design of such a crushing unit so that lifting of the ore to the maximum height of the inner diameter of the apparatus is effected, and special steps are taken to facilitate reduction by gravitational impact, by providing stationary metal-impact surfaces at the bottom. The problem involves a radical increase in the diameter of the apparatus, means to elevate the rock, provision of fixed concussion plates, and arrangements for the removal of undersize as produced.

Mr. A. D. Hadsel, of California, has shown initiative and ingenuity in translating these requirements into the range of practical ore crushing. A unit of a new mill, described elsewhere in this issue, consists of two large drums, on the inside of which is arranged a series of buckets, larger in comparative size and fewer in number but nevertheless somewhat similar to the buckets in the tailing wheels that proved so economical and efficient as pulp elevators in South Africa and elsewhere in the early days of the cyanide process. In the Hadsel mill, the ore is dropped as the buckets reach an emptying position high on the ascending side. Impact against metal plates in the bottom of the mill effects reduction. Exit of crushed material, aided by water as a classifying medium, occurs through screens, the oversize being subjected to repeated elevations until the desired result is obtained.

Millmen will recognize the interrelationship between friability of ore and height of lift. Mr. Hadsel finds that a 24-foot drum is adequate to produce the necessary momentum in the treatment of a Californian quartz ore to be reduced to pass 80 mesh. Practice in South Africa indicated that objection to the unwieldiness of a piece of mill equipment such as the familiar tailing wheel was merely the result of prejudice against radical change. A wheel of a diameter of 60 feet, not an uncommon sight, operated satisfactorily as a simple lifter.

Mr. R. G. Hall, who has reported on this new crusher development, pictures the various stages of reduction. "It is interesting," he says, "to watch the progress of the larger pieces of ore, some as heavy as 150 pounds apiece. The first impact on the plate seldom effects breakage, but the falling rock effectively smashes the material between itself and the plate. Unless it be nearly spherical, it will remain on the plate for a perceptible period, while a torrent of other material, from sand to boulders, pours upon it. The edges and salients are broken off, and the piece is actually driven, by the torrent of rocks, off the plates and back to the wheel. For about three trips a large piece may maintain a size that permits identification; then it is absorbed in the mass of material of intermediate and smaller sizes."

Further results of the Hadsel system of crushing on various types of ore will be awaited with interest. Whatever the adversity of reaction to innovation, the system has the merit of simplicity—a factor usually connoting economy as well as promising mechanical efficiency.

## Transplanting Engineers Productive of New Ideas

GREAT BENEFITS often follow in the train of great disasters. The scattering of Constantinople's philosophers and cultured men, after the city's downfall in 1453, brought about a revival of learning in Western Europe, ending the so-called dark ages. The technologic unemployment of today, the uprooting of men from long-held positions and vocations to which many are likely never to return, is creating a steadily mounting surplus of brains and varied skill, available for service. This talent seeks re-employment, preferably in activities with which it is familiar. But if opportunity for service be long denied, brains and skill must go a-begging, and in the end will accept any master who can furnish food and lodging. Thus, in many lines of industry, men trained for other work will find a foothold, perhaps near the bottom of a new ladder. These, because of different points of view and experience, will bring to their tasks new ideas that will make for progress in departments of industry with which they formerly were unfamiliar.

Profit from this upheaval and transplanting will be realized by the mining industry. Engineers who have hitherto regarded the mining and treatment of metallic ores and minerals as their proper field are being forced to look to other divisions of the industry for employment. Likewise, the coal-mining engineer will regard metals as worthy of attention. Eventually, one may expect to find the distinction between these groups less well defined than it has been in the past. Particularly, the non-metallic division of the industry may hope to reap advantage, for this branch of mining and ore bene-

ficiation has attracted men of engineering training far less than the problems it offers for solution would seem to warrant. Its mining is not confined to open-pit work, as many take for granted. For example, in the United States in 1929, four non-metallic minerals were mined by room-and-pillar methods to the extent of 16½ million tons, according to Mr. J. R. Thoenen, of the United States Bureau of Mines. The relative percentages of non-metallic mineral products to be extracted in the future by underground and open-pit methods seem likely to change eventually in favor of the underground mine, because of the gradual deepening of operations started on the surface. Processing methods from standard technique in the non-ferrous industries are being adopted successfully. In this field lies the greatest promise for the mining or metallurgical engineer who finds himself unemployed, or who seeks diversification of experience.

## Clarification in Practice and Description

A FEW YEARS AGO a plea was made to the pioneers in an infant metallurgical industry, concerned with the electrolytic production of zinc, that technical terms should be used as tools of precision. Objection was raised to the use of the word "leach" as synonymous with "agitate." To metallurgists accustomed to associate leaching with a dissolution and displacement process such as is in use at Chuquicamata, an account of a new hydrometallurgical development proved confusing. Attention was drawn to the fact that the word "leach" is derived from the Anglo-Saxon word "leccan," meaning to wet or moisten. This is the primary definition given by Webster. The second meaning is: "To percolate (a liquid) through something, as ashes"; and a third definition is similar: "To subject to the action of percolating water or other liquid in order to remove the soluble parts; to lixiviate; as to leach ashes or coffee"; a fourth definition is: "To dissolve out by the action of percolating liquid; often used with *out;* as to leach out alkali from ashes." "Percolation," be it noted, infers the passage of a liquid through the interstices in or between particles of solid matter, at rest or in suspension.

Frequent use of the word "leach" and "leaching" in one of the papers presented at the recent meeting of the A.I.M.E. in New York revives the subject of clarity in technical description. The operations in question cover sundry phases of continuous processing, primarily agitation and countercurrent displacement. Normal agitation is not leaching in the accepted sense of that term, but the progressive impoverishment of a slime or a sand effected in thickeners or classifiers in series may be considered as a phase of leaching: one may assume that a dissolution of soluble occurs simultaneously with a separation of the valueless from the valuable; but, in order to differentiate such an operation from the lixiviation of stationary charges of ore, it might be designated as "countercurrent leaching"—a term that should deflect attention to a technique developed to wide application by the pioneering work of Dr. J. V. N. Dorr and associates, as the direct result of the introduction of mechanical classification and mechanical thickening.

## Avoidance of Waste Is Good Engineering

SYSTEM, order, and cleanliness are closely related to efficiency, and a realization of this fact is prompting closer attention to plant design, to proper plant lighting and ventilation. Unnecessarily close grouping of machinery is being avoided. Automatic equipment is replacing hand labor. Minor plant improvements are legion. Much remains to be done, however. Particularly, the power house, repair shops, and storerooms have been neglected, despite expenditures for plant modernization. Power plants and repair shops equipped with obsolete machinery mean high generation and repair costs, which in turn affect detrimentally over-all production costs. Inefficient handling and storage of supplies involves waste. Materials cannot be effectively distributed and checked if stored in the cellar, in an extension of the power house, or among the tools at the machine shop. Nevertheless, such methods are practiced at a surprisingly large number of properties. Moreover, the help-yourself attitude encouraged under such conditions—the waste arising from an unchecked distribution of oil, nuts, bolts, and other goods—cannot be counterbalanced by periodic house cleaning. Estimation is impossible of the number of working hours lost by such methods. With low metal prices, and the necessity to reduce operating costs in line with current economic conditions, the progressive executive will take the opportunity that now presents itself to make a careful survey of handling and storing practices. Savings in working hours and materials effected by an orderly distribution and storage of goods will more than repay the initial cost of reorganizing the department or building a new storeroom.

## Sheet Copper Produced Directly by Electrolysis

NEVER was the urge to profit during a period of adversity more keenly felt than it is today. The mining industry is exhibiting an ability to adapt operations to meet diminished returns that provides testimony to the energy and resourcefulness of those upon whom the responsibility rests. Copper producers, faced with greater stocks than at any previous time in history, are looking to increased consumption as the means of restoring an equitable price for the metal.

Of interest in this connection is a recent development at Raritan Copper Works, one of the Anaconda subsidiaries. After extensive experimentation, the problem of producing sound laminate copper by electrolytic deposition has been successfully solved. Continuous sheets, free from pinholes and other imperfections, and of an appearance equal to that of rolled metal, are now produced on a commercial scale by deposition on revolving cathodes. Within reasonable limits the sheets may be produced in any lengths, and, with the present equipment, in widths up to 48 inches. The thinnest sheets now being made are 0.0017 inches thick, weighing one ounce per square foot. Sheets of this thickness cannot be produced in greater widths than six inches by rolling. Other standard sizes are two and three ounces; seven

ounces appears to be the upper limit, beyond which rolling will probably be more economical.

Many interesting uses await the new product. At present the sheets are used for wrapping underground oil and gas lines, to protect against corrosion and soil stress. On account of its low coefficient of friction, the smooth copper surface permits the settling ground to slide past the pipe without bending or cracking the cover, whereas rougher materials, such as tar paper and similar products, often bulge and crack, leaving the iron pipe exposed to the corrosive action of the soil. The new product is also used to cover the insulating materials on pipe lines in oil refineries; canvas, commonly used for this purpose, has a tendency to crack and rip when exposed to the elements, with the result that much damage may occur during a heavy windstorm. With a backing of fabric, fastened by a suitable adhesive, the sheets may also find use as roofing material and for vertical structures.

An interesting possibility considered by automobile manufacturers is the use of thin sheet copper for car tops. In this application a fabric backing is also required. The copper, placed on the outside, is crimped and painted to present the appearance of leather. In addition to perfect resistance to atmospheric attack, such a top has the advantage of being fireproof. That other applications will be developed as the product becomes better known in the manufacturing field would seem a safe prediction, to the advantage of all concerned.

## Adverse Business Conditions Stimulate Research

THE large number of highly trained research investigators that are unemployed indicates that numerous companies have been pruning expenses for 1932 beyond the point of real economy. Annual reports of those companies that made a profit in 1931 indicate that the result was attributable to the manufacture of new products developed by research to meet unfilled needs. Similarly, an investigation of raw-material producers would show that those weathering most successfully the current economic situation have employed and are employing research workers to expand markets.

A specific instance is revealed in a statement in the annual report of the International Nickel Company for 1931: "Notwithstanding the severity of the present world-wide depression, the company has been affected less adversely during this period than during the industrial collapse of 1921 . . . Sales of nickel in all forms during 1931 were largely in excess of similar sales in 1921, showing an increase of 104 per cent. This comparison is significant in that it clearly indicates that the consumption of nickel is increasing more rapidly than that of most other metals. This satisfactory increase in sales is to be attributed not only to the recognized value of nickel but to the fact that, for the past ten years, technical research and development have been employed on a progressive scale to demonstrate its worth and to extend its uses."

In the light of such information and opinion, the research worker may be given credit for at least minimizing the effect of this period of adverse business conditions. He will be an important factor in a return to more satisfactory circumstances. His services are probably more valuable than ever they were. Progressive executives are realizing that his retention on the payroll is likly to insure new sales opportunities and so effect improvement in company morale and financial prospects.

## Russia Must Watch Production Costs

THE complex nature of modern industrial activity renders a simple statement of the financial condition of any given enterprise extremely difficult to compile. The annual reports of leading mining companies show an amazing variety of accounting methods; those that follow a uniform practice in charging expenditures to capital account may employ different practices in determining inventories or production costs. No one can say what the correct method is. Although nearly all economists and technical journalists are united in pleas for uniform practice, no method has yet been devised that will satisfy the conflicting demands of all companies.

If bookkeeping is a precarious art under a capitalist system, where most enterprises have the common motive of profits, it becomes even more fraught with danger in a Communist enterprise such as that on which Soviet Russia has embarked. As an instance, a news item in the February issue of this publication can be quoted: At the Kounrad copper properties in Kazakstan the Soviet engineers have estimated that the reserves contain 1,500,000 tons of copper in ore averaging 1.2 per cent. A concentrator and smelter are being built, and a 550-mile railroad is under construction to unite the properties with the Trans-Siberian line. According to estimates, the total cost of this enterprise will be 250 million dollars, not roubles.

These figures are taken from an article by Mr. V. M. Karmashov, a Soviet official, who also stated that the country through which the railroad passes is almost entirely barren. Most of the freight will apparently be furnished by the copper mines, and therefore the cost of constructing the railroad is a proper capital charge against the cost of producing the copper. Under these circumstances the conclusion can be drawn that the copper known to exist in the Kazakstan deposits will have cost $150 per ton, or 7½ cents per pound, in capital charges before mining is begun. Low operating expense is not likely to be achieved with ore that averages only 1.2 per cent copper. Total costs, including capital charges, will probably be at least fifteen cents per pound, therefore, and possibly much more. Of course, the Soviet government may have good reasons for believing that other sources of freight for the railroad will be developed, or that additional copper will be found at Kazakstan; but, on the basis of the figures presented, and under present conditions in the world copper market, the venture seems to be definitely uneconomic.

This instance serves to illustrate the serious danger confronting collective societies—that, because of the removal of the line of demarcation between producer and consumer existing under the capitalist system, uneconomic practices will be engendered. Soviet Russia cannot hope to improve the living standards of its peoples unless

careful check is kept on production costs. If many of its enterprises are capitalized at rates comparable with the expenditure being made at Kazakstan, efforts to produce consumable goods will be seriously handicapped, and the production of raw materials may involve a cost greatly in excess of that incurred to obtain similar products in other industrial countries. The Russian people will not be able to raise standards of living and consumption of goods to a point at which they can afford to pay for domestic commodities at prices that are far above those prevailing elsewhere.

## Applying Research in Solving Underground Problems

THE opportunity for research on rock pressure and rock behavior under pressure, mentioned in these columns in 1927, prompted Mr. Frank H. Probert, dean of the College of Mining, University of California, to write as follows: "You wisely and forcefully point out the urgent need of an intelligent understanding of the way rock masses behave under varying conditions of stress and strain, natural or induced by mining operations. . . . The science of petrodynamics is in its infancy. I predict its vigorous growth and widespread usefulness: it needs fostering, development, and encouragement, for which it will in the future yield abundant return."

A new approach to the acquisition of knowledge in the field of petrodynamics has since been developed at Columbia University, one that has attracted the attention of operating mining engineers as well as research investigators. The method, developed by Mr. Philip B. Bucky, assistant professor of mining, is based on the use of models and the application of the principles of dynamic similarity. The theory involved suggests that, if the material composing the model is the same as that of the mine structure, and if the density of the model is increased in the same proportion as its size is decreased, what occurs in the model will be similar to that which occurs in the structure, within and beyond the elastic limits of stress for all materials or combination of materials. In applying this theory, as witnessed in the course of experiments performed recently by Professor Bucky at the university laboratories, the effect of an increase in density of the model is obtained by rotating the model in a centrifuge and allowing it to exert pressure against the centrifuge end plate. The behavior of the model—a slotted beam of sandstone—was observed with the aid of a stroboscopic mercury arc.

In discussing the field of application of the method, Professor Bucky emphasizes the fact that it is applicable only when the model is truly representative of the structure it represents. He admits that much remains to be done in the design and construction of laboratory equipment and in making models, but he expresses hope that the knowledge developed may be of value in stimulating further research in mining; that it will eventually place mining on the same basis as metallurgy, from a research standpoint. In this direction, particularly, Professor Bucky's work promises to achieve much of economic value and scientific interest.

## Metallurgical Technique and Increasing Gold Production

ELSEWHERE in this issue will be found the results of an elaborate study of the economics of gold production, by Mr. S. D. Strauss, of particular interest to the producer, actual and prospective. An unparalleled opportunity presents itself for exploitation and promotion of properties in a branch of the mining industry in which product demand is unlimited, in which a ready market exists for a metal at a price that is unusually attractive, taking into account the existing low cost of commodities and service.

In spite of these favorable factors, however, progress in increasing output has not been as rapid as might have been expected. Developments that have occurred in comparatively recent times should have been given an impetus long since; and they would have been but for a weakness in the professional structure, which indicates that the specialist in the metallurgy of gold is in hiding or is being ignored, although his knowledge and experience entitles him to a fair share of the recognition accorded to the profession as a whole.

An expansion in gold production is mainly dependent on the application of a correct metallurgical technique. As timely today as when the point was emphasized in this publication a decade ago is the reminder that the non-technical or inexperienced individual who wants impartial opinion on the treatment of a gold ore is at a loss how to proceed. He turns to the technical press and finds recent practice exemplified in one new installation by the retention of amalgamation as a preliminary to cyanide treatment, whereas in another he discovers that it has been discarded; in one instance all-sliming is adopted; in another there is a reversion to bulk leaching; in another, flotation and cyanidation are practiced.

The general answer to this apparent want of agreement is that ores differ in composition and characteristics, although identical ones are being treated by fundamentally different methods. Gold is easily recovered from most ores. The richer the mine, the less the call for expert advice—this philosophy has been largely responsible for the paucity of consultants, and the lack of interest shown in the development of low-grade deposits, the treatment of which calls for a confidence similar to that accorded to specialists in the hydrometallurgy of copper, and a capital expenditure such as was made available to them until success was achieved. For specialists in the metallurgy of gold, who should have earned the distinction of being classed as experts by reason of training, varied responsibility, and professional achievement, this publication again makes a plea that they be recognized as necessary in a branch of technology that deserves encouragement and demands the application of a high standard of specialized knowledge and a broad experience in engineering, chemistry, and metallurgy.

# Healthful Smelting Conditions Promote Efficiency

R. P. E. Hermsdorf and R. Winters

*In the new lead plant at Carteret, N. J., United States Metals Refining Company has furnished a fine example of thoughtful design and careful planning to eliminate all hazards formerly considered unavoidable in a plant of this kind. Precautions have been prompted by rigorous State laws on occupational diseases and an earnest desire on the part of the company to promote the health and well-being of the workers.*

THE lead plant of United States Metals Refining at Carteret, N. J., has two smelting units, a 44x11-ft. reverberatory furnace with bottom, roof, and upper walls of clay brick, magnesite walls to the metal line, and sides and ends completely water-jacketed up to the metal line; and a 9x3-ft. blast furnace with a tuyere area of 27 sq.ft., equipped with a lead well and a slag-matte tap discharging into a settler from which slag, matte, and some lead are tapped. A drag flight conveyor, made by Dodge Manufacturing Company, with a capacity of 15 tons per hour, handles the lead material to the reverberatory furnace; it has flights of 9x4½-in. hard iron, spaced at 4-in. centers and running about 16 ft. per minute. The blast furnace is served by a 3-ton electric hoist, with monorail trolley, furnished by Hoist & Crane Manufacturing Company. A utility reverberatory furnace, 14x8 ft., of construction similar to that of the smelting furnace, is used for various purposes as occasion arises. Two softening furnaces, each 22x11 ft., have brick lining and water jackets like those of the reverberatory furnace. On the kettle floor are three 120-ton cast-iron kettles for desilverizing, chlorination, and casting, and one 40-ton cast-iron kettle for antimonial lead. A 10-ton overhead Harnischfeger crane, with a 77-ft. span, serves all kettles and is also used for lead shipments. Zinc crusts are treated in two furnaces of standard Faber du Faur type, with retorts and condensers of Dixon graphite. Adjacent to the retorts are two cupels for treatment of retort bullion, with sides and bottoms completely water-jacketed. The lining is of clay brick except at the metal line, where magnesite brick is used.

All furnaces discharge into an elaborate, balanced flue system, through a series of cooling flues, connected with an automatic shaking Northern Blower baghouse. This baghouse consists of two units of twenty compartments, each equipped with 25 woolen bags, 8 in. in diameter and 10 ft. 3 in. long, made at the plant from Duralin woolen cloth. Five large Northern Blower fans insure positive draft on all furnaces and keep lead fumes from escaping into the atmosphere.

Furnaces, kettles, and retorts are heated with heavy oil of 14-16 deg. Bé., stored in two 20,000-gal. tanks, heated by steam coils. The oil, pumped through an extensive loop piping system to all parts of the plant, is kept warm by running steam lines alongside the oil lines, wrapping the lines together with a hair-felt covering. Steam for oil heating and for hot water used in the wash room is furnished by two 50-hp. Kewanee boilers. A central pumping system circulates water through the water jackets on the furnaces. Return water is pumped to a cooling tower and recirculated. Two 750 g.p.m. 5L-1 Worthington single-stage centrifugal pumps are used. Power is purchased. Alternating current is used throughout, except on the kettle floor for pumps and agitators, where direct current is safer for the men, who are continually handling extension cords for this equipment. Direct current is produced with a Westinghouse motor-generator set.

The reverberatory furnace is charged through three openings in the center of the roof by a drag conveyor and Fahralloy chutes, a completely dustproof charging system that has given satisfactory results. The drag conveyor is fed by an inclosed belt conveyor from the outside of the building, and the charge is not exposed in the building until it drops into the reverberatory furnace. The inclosed conveyor is fed by two other 24-in. Dodge belt conveyors, one coming from a pug mill mixing fine material and flue dust, the other from a Trojan M-2 hammer mill, which breaks down all coarse material.

Only two products are made in the reverberatory furnaces—an antimonial slag and a bullion. The slag is run and skimmed from side doors near the uptake end of the furnace, the metal is tapped from the end of the furnace and laundered to a kettle or to a softening furnace according to the copper content of the lead. This arrangement is shown in Fig. 2. If the copper content is high, the lead is run to a 120-ton kettle; if low, to one of the softening furnaces.

If run to a kettle, the lead is cooled, decopperized, skimmed, and pumped into one of the two softening furnaces. If run directly to a softening furnace it is cooled to permit removal of the copper skim before the regular softening operation is started. Two skims are made in softening, first a tin skim, fol-

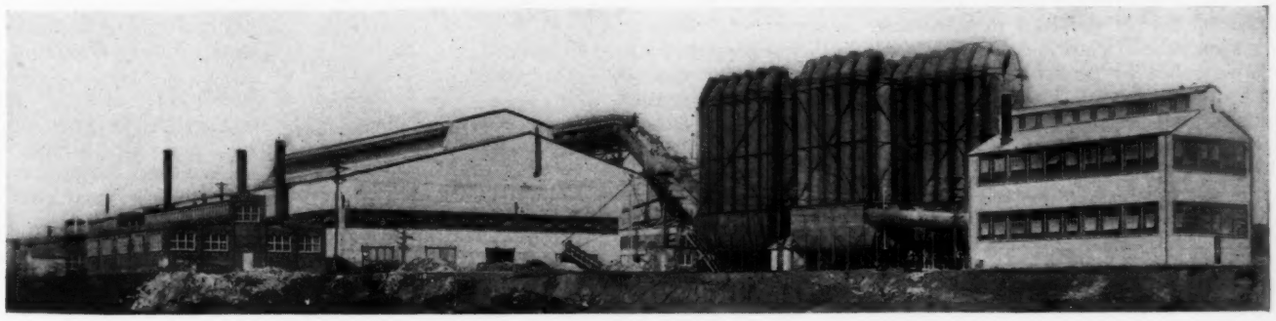

**Fig. 1—General view of plant, showing change house, main building, cooling flue, and baghouse**

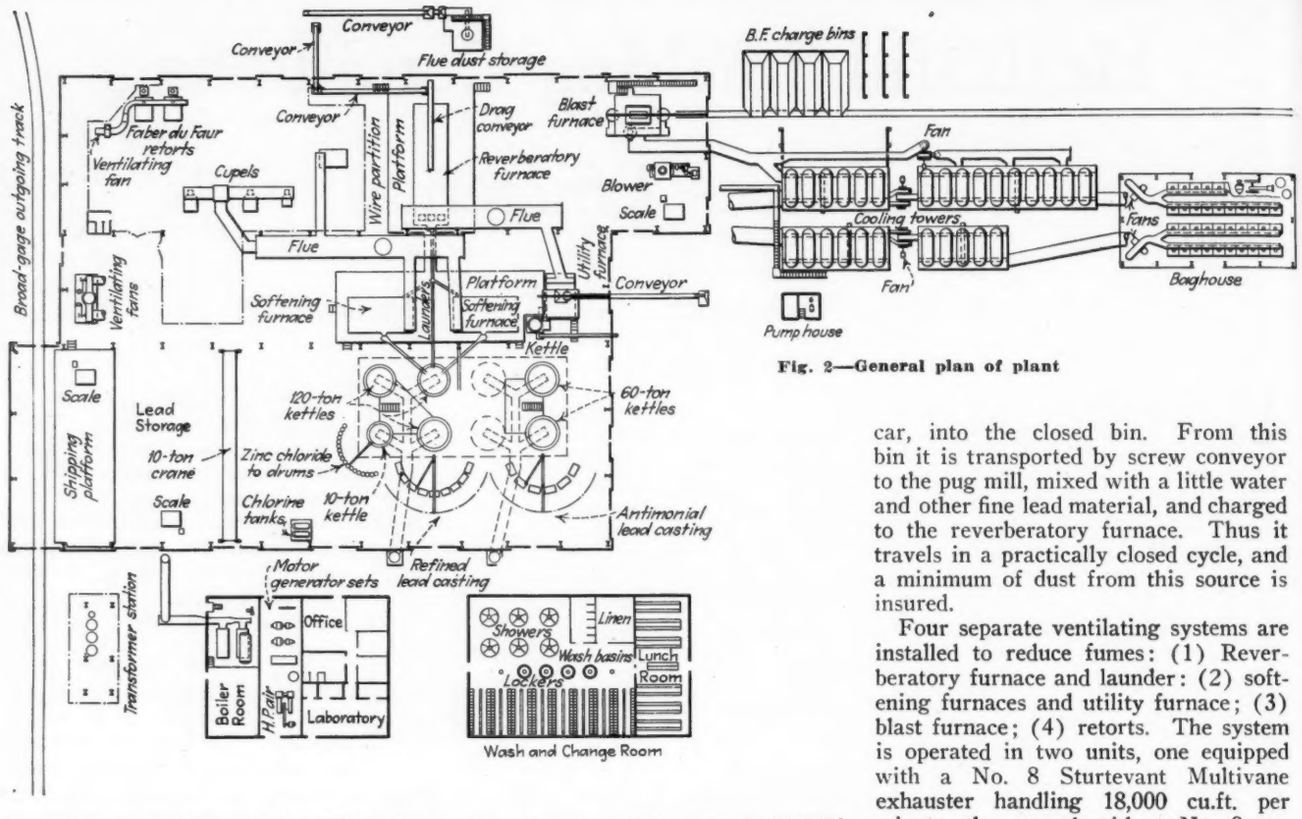


**Fig. 2—General plan of plant**

lowed by an antimony skim. They do not differ sufficiently in analysis to warrant keeping them separate. No intermediate skim is required, as the original charge contains very little arsenic.

Softened bullion is tapped to a 120-ton kettle and desilverized with zinc by the Parkes process. After squeezing in a hydraulic basket press to remove as much lead as possible, the zinc crusts are delivered to the retorts. Recovered zinc is returned to the desilverizing kettles, and retort bullion is transferred to the cupel furnaces, where it is refined to doré by blowing air across the surface, the litharge formed carrying off the impurities. The doré is sent to the silver refinery of the copper plant, and the litharge is returned to the lead smelting operations.

Then the desilverized lead is pumped to the 120-ton chlorination kettle, where the zinc held in solution in the lead is removed with chlorine, by the Betterton process. This is accomplished by pumping the lead through a cylinder into which chlorine is passed, whereby zinc chloride is formed, which collects as a crust on top of the lead in the kettle. As soon as lead chloride, which may be distinguished by its white color, starts to form, almost all zinc has been removed and dezincification is complete. The zinc chloride is transferred to a 10-ton kettle, purified with metallic zinc, and pumped into steel drums for the market. De-zinced lead is pumped to the 120-ton casting kettle, where it is drossed, after which it is pumped to the molds and cast into 100-lb. pigs for the market. A typical analysis of refined lead is as follows: Copper, 0.0015 per cent; antimony, 0.001; arsenic, 0.0006; bismuth, 0.04; zinc, 0.001; iron, 0.001 per cent; tin, a trace; and silver, 0.20 oz. per ton.

The slags from the reverberatory furnace and from the softening furnaces may be of high or low silver content, according to the tenor of the charge. If high in silver, they are treated in the utility reverberatory furnace. This furnace is charged through the roof by a belt conveyor and cast-iron hopper with a Fahralloy section at the entrance to the furnace, a method of charging reducing the amount of manual labor and minimizing dusting. The metal is pumped back to the softening furnaces, and the slag transferred to the blast furnace for an antimonial lead run.

If low in silver, the slags are transferred directly to the blast furnace and blended with the antimonial slags from the utility furnace and other lead materials, to produce antimonial lead, which is cast into 2½-ton pigs at the blast furnace and transferred to a 60-ton kettle, where it is blended as desired and decopperized. It is then transferred to another 60-ton kettle and cast in water-cooled molds to 80-lb. pigs. The utility reverberatory furnace is also used for the treatment of black-copper drosses skimmed from kettles.

The baghouse and the cooling flues are equipped with screw conveyors, which take all flue dust to centralized points, where cars, completely closed, are so placed that no dust can escape into the atmosphere or fall to the ground. The covered cars are then hauled to the flue-dust storage bin and the dust is drawn by a strong suction pump, through a pipe inserted in the car, into the closed bin. From this bin it is transported by screw conveyor to the pug mill, mixed with a little water and other fine lead material, and charged to the reverberatory furnace. Thus it travels in a practically closed cycle, and a minimum of dust from this source is insured.

Four separate ventilating systems are installed to reduce fumes: (1) Reverberatory furnace and launder: (2) softening furnaces and utility furnace; (3) blast furnace; (4) retorts. The system is operated in two units, one equipped with a No. 8 Sturtevant Multivane exhauster handling 18,000 cu.ft. per minute, the second with a No. 9 exhauster handling 30,000 cu.ft. per minute. In each of the first three systems the fan used is large enough to draw off any fumes near the intakes of the ventilating system. Fumes are drawn off with high velocity and low volume rather than by low velocity and high volume. At each danger point the fume is arrested at the source, and a velocity of at least 2,000 ft. per minute is maintained at the tip of the ventilating duct. A typical group of ventilating ducts is shown in Fig. 3.

Ventilating ducts at the reverberatory furnace are placed over each skimming door, at the lead tap hole, and all along the launder transferring hot molten lead to the softening furnace or kettles. Similar ducts are placed around the softening furnaces and the utility furnace. At the blast furnace the ducts are placed at lead well, slag tap, settler matte tap, and settler lead tap. All individual ducts may be closed with butterfly dampers when no fume is generated. Thus the suction of the fan may be concentrated on a few points. This ventilating arrangement, found satisfactory, has helped greatly in keeping the air in the building free from fume.

The fourth ventilating system is installed at the zinc retorts to draw off fumes released in tapping zinc or pouring bullion. In this case a large hood is placed over the whole retort and condenser, as the heavy fumes cover a larger area. This gives a condition of low velocity and high volume, and care must be taken to prevent cross currents that would blow the fume away from the hood.

Although lead fume is generally conceded to be the form in which the metal is most easily absorbed by the human system, lead dust is probably the most common cause of poisoning, on account of its greater abundance. Elimination of all dust is, therefore, one of the most important problems in a lead plant. In the first place, every precaution must be taken not to create dust in handling, smelting, and refining lead material, along the line described. The next move toward elimination of lead dust is general cleanliness—a point of importance in any plant and of vital importance to a lead plant. Tools, pipes, rabbles, old bricks, and other junk scattered on the premises offer excellent opportunities for accumulation of lead dust.

In a well-designed plant the current dust may be removed daily with comparative ease. This is usually done by sweeping, after sprinkling with water or wet sawdust. Places where much fine material is handled are so constructed that they may be washed down with a hose several times a day. The water runs down a sewer to a sump, where the lead material may be settled and recovered. In the baghouse, where washing with water is impracticable—the wet dust would form a sticky paste—a large vacuum cleaner, shown in Fig. 4, is used for immediate removal of flue dust that is spilled.

After taking all precautions to arrest fume and dust at the source, a few places still remain where dust may occur, as for instance where cars are unloaded. As a precaution additional to wetting this material, the men engaged in this work are required to wear respirators, to prevent dust from entering the system through the respiratory organs. A respirator has been developed which has proved most satisfactory and beneficial. The mouthpiece extends well below the lower lip, and the nosepiece is adjustable. These two items are of the greatest importance; for unless the respirator fits snugly around the contour of the nose ridge and the mouth, the air can pass through, and the man will work under a false sense of security. The respirator bag is inflated with a light bronze coil spring. The inflated bag makes breathing easier. Easy removal of the bag from the mouthpiece permits the use of any number of bags during a working period. The bags are washed, disinfected, and treated with harmless chemicals to increase the efficiency of absorption.

To insure general hygienic conditions, and in particular to prevent lead from entering the human system through the mouth and stomach, a building 88 ft. long and 54 ft. wide was constructed, which contains the wash room, lockers, and lunch room. The wash room contains 30 shower baths and four round wash stands, equipped with hot and cold water. Ten men can wash at each stand at one time. Each man is assigned two steel lockers, one for street clothes and one for working clothes. In addition, individual lunch lockers are provided for all men.

The general routine adopted for this building is as follows: Men coming to work must first leave their lunches in the lunch lockers, which are locked by the wash-room attendant or foreman. They then undress, place their street clothes in the locker designed for that purpose, and put on working clothes. At lunch time they return, wash their hands and faces thoroughly, rinse their mouths, and brush their teeth with tooth brushes supplied by the company. After presenting themselves at the door of the lunch room for inspection of hands and face, they are then given a white smock, large enough to cover their working clothes completely. As lunch boxes are opened, they remove their lunch and proceed to one of the tables in the lunch room, where milk may be bought at cost. Although this may seem a long procedure, the men, when accustomed to it, go through the routine rapidly and thoroughly. That this is a great preventive measure cannot be disputed, as a man may easily contaminate his food with lead if his hands are dirty. At the end of the shift the men remove their working clothes, take a shower, dress, and return to their homes clean. All men are supplied by the company with "unionalls," which are washed twice a week. This leaves no excuse for not changing from street clothes to working clothes, or vice versa, and provides the men with as dustproof a working uniform as may possibly be obtained.

In addition to verbal instructions and warnings by the employment department, the doctor, and the lead-plant foreman, each new employee is given a pamphlet with rules and regulations, for which he is required to sign a receipt. The rules and regulations follow:

The State of New Jersey requires the employer to take precautionary measures for the prevention of occupational disease. These precautions are taken for your protection. The United States Metals Refining Company has complied with all these requirements to the letter of the law. The State of New Jersey also requires the employees to observe the rules of law as set forth under Act P.L. 1914, Chapter 162, Section 4, State Labor Law, as follows:

"Every employee who, while engaged in any work or process, is exposed to lead dust, lead fumes, or lead solution, shall: (a) Use the washing facilities provided by the employer, and wash himself as often as a time allowance is therein granted for such use. (b) Use the eating room provided by the employer, unless the employee goes off the premises for his meals. (c) Put on and wear at all times, while engaged in such work or process, a suit of clothing provided by the employer, and remove same before leaving at the close of the day's work; and keep his street clothes and working clothes, when not in use, in separate lockers or separate parts of the locker provided by the employer. (d) Keep clean the respirators provided by the employer, and use one at all times while engaged in any work or process which produces lead dust and is exposed to such dusts."

*Plant Regulations* are as follows: "(a) Smoking in the plant is prohibited, except during lunch time, and then only in the lunch room. (b) All food must be placed in lunch lockers provided by the company; (c) No food must be eaten on the job; a lunch room has been provided for this purpose and an adequate time allowance is given for eating. (d) Before eating you must wash your hands, wash your face, brush your teeth, rinse your mouth, and put on a smock, provided by the company, to be worn over the outer garments and put on before entering the lunch room; (e) Drink plenty of milk; it is sold to employees at cost. (f) Take a shower at the end of each day's work. Hot and cold water, soap, and towels are provided by the company. (g) Respirators must be worn wherever there is dust or fumes; you will be instructed in their use by the foreman. (h) Put on unionalls, provided by the company, before starting work, and leave your street clothes in locker, also provided by the company. Separate lockers are provided for street clothes and working clothes. All working clothes must be left in the plant."

*Suggestions* to employees are classified thus: (1) Alcoholic liquors weaken the system and make it more liable to disease. Employees are urged to abstain from the use of all alcoholic liquors. (2) Do not chew tobacco while at work;

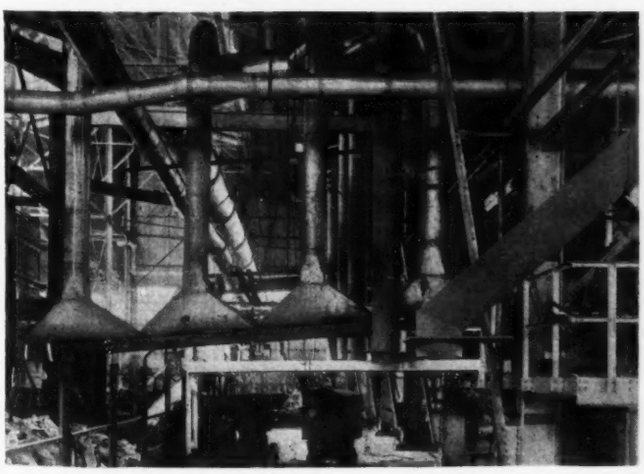

**Fig. 3 — Fume ducts along launder to softening furnaces**

**Fig. 4—Vacuum cleaner used in baghouse**

for, in handling tobacco with dirty hands, dust may be carried into your mouth. (3) A hearty meal should be eaten before starting the day's work. (4) If your bowels do not move at least once a day, get a laxative from the plant physician. (5) If ill, report to the plant physician at once. Do not injure your health by taking home remedies, or the advice of friends or drug clerks who are not licensed physicians. United States Metals Refining Company's Medical Division is capable in taking care of your physical ailments, and as a loyal employee, and in fairness to the company and to yourself, you should submit yourself for treatment to our medical organization. (6) United States Metals Refining is interested in your health and welfare as an employee. You are part of this organization and your cooperation with the company will go far toward maintaining the high standard set up for the preservation of health.

"If the rules as set forth in this pamphlet are carried out, there is no reason why you should not keep in good health. Any violation of State or Plant Regulations contained herein will result in immediate dismissal."

Medical science has generally accepted the theory that some individuals are more susceptible to lead absorption than others. For this reason a thorough physical examination is given to all men before engaging them for work at the lead plant. This examination includes blood, urine, and sputum tests.

After the man has been employed, strict medical supervision follows, and systematic clinical re-examinations are made at intervals of three to four weeks, to determine the health status of the worker. Such examinations determine which individuals are susceptible. Those found so are immediately transferred to other work. As a general rule, a healthy individual using ordinary precautions while working in lead, and following ordinary hygienic practice in private life, will not be susceptible to lead absorption.

The medical division of United States Metals Refining consists of a medical director, a full-time plant physician, a first-aid attendant, and a technician. The medical director is charged with full control over medical supervision of all employees. All physical examinations, supervision of first-aid work, the clinic, and the technical laboratory are under the supervision of the plant physician. The first-aid clinic is elaborately equipped for thorough physical examinations and general first-aid work. The technical laboratory is adjacent to the first-aid rooms. In all this work a close coordination and cooperation of the employment department, the medical division, and the operating department is essential.

To give the workman the greatest protection, continual air tests are necessary to determine when, where, and why air contains lead. Whenever a place is found where lead exceeds the safe limit, an investigation is immediately made to find its source, and steps are taken to prevent a recurrence. Air tests may be made with a Greenberg-Smith impinger apparatus or an Anderson & Armspach dust determinator. The former has been used by the U. S. Health Service, and a description of the method is given in U. S. Public Health Bulletin No. 1637. The U. S. Public Health Service has considered 0.000009 milligrams of lead per cubic foot of air as the threshold value. In this work all chemical analyses should be made by expert chemists, as the determinations are delicate.

In making air tests, several factors have been found important in setting up the apparatus. A study of the air currents by means of anemometer is first made in the vicinity of the area being tested, so as to determine direction and approximate velocity of the air currents. The orifice of the suction tube on the impinger apparatus is then faced in the direction of the air currents, placing the apparatus not more than 5 ft. or less than 6 ft. from the floor—the strata in which the men work. If a non-permissible amount of lead is found in the atmosphere, the air currents are followed backward and forward, and up and down, if necessary. Generally, this is not necessary, however, as the source can usually be located from one testing station, if well chosen in the first place. Zoning the building in areas and studying the operating conditions have been found helpful in securing data and making records, as well as for check tests.

To determine the efficiency of various filtering mediums for respirators, an apparatus has been devised in which artificial lead fumes, at various temperatures, are generated in a small electrically heated kettle. The fumes are first drawn through the material being tested, and the exhaust is passed through a series of impingers. The amount of lead collected in the impingers for a given volume of gas is then determined. This is repeated with various filtering cloths, in each instance using the same temperature in the kettle, and drawing the same volume of gas. Although the exact lead content of the original gas is not known, the lead collected by the impingers shows the relative efficiency of the filtering cloth. This method has been very helpful in selecting the best materials for respirators.

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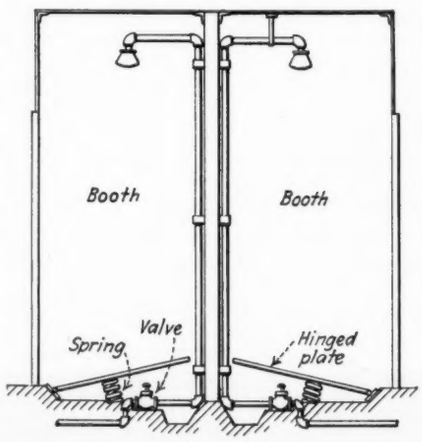
## Shower Room Design in South Africa

PREVENTION of waste of domestic water on the Witwatersrand has been achieved by replacing the conventional hand-controlled appliances in the showers of the native compounds with the simple yet effective arrangement shown




in the accompanying sketch. It consists of a hinged plate and a small spring-controlled globe valve, both secured to the shower-booth floor. Two springs are provided to hold the plate well above the protruding valve stem. As the bather enters he steps on the plate and so depresses the valve stem, thus permitting water to flow to the shower placed overhead. When he leaves the booth the hinged plate and the valve return to their natural positions, shutting off the water supply, instantly. Free use of the bather's hands for washing is an additional advantage.

# Lubrication and Economics

E. R. Woodward

A GROWING APPRECIATION of the economies to be derived from a careful study of operating details is leading to the adoption of more scientific methods of lubricating mining machinery. Breadth of interest is evident when one considers that the management is concerned over the problem of reducing production costs, the operating engineer is responsible for the efficiency and smooth running of machinery and equipment, and the purchasing agent aims to buy lubrication at the lowest price.

A thorough study of lubrication involves a survey of the types of machinery and apparatus used in mine, mill, or smelter, due regard being paid to their lubrication systems. The characteristics of lubricants must also be studied, and reference will therefore be made to principles upon which those interested in the application, testing, or purchase of lubricants may base practical conclusions.

Crude petroleum is composed primarily of carbon and hydrogen, combined in the form of hydrocarbons. These hydrocarbons, at normal temperature and pressure, occur in the gaseous, liquid, or solid form, depending on the relative proportions of carbon and hydrogen in the molecules. A study of lubrication involves consideration of only the liquid-phase and the solid-phase hydrocarbons, the latter chiefly in a negative way, because they comprise (a) the paraffin waxes, which must be removed to an extent depending on the cold test or pour point required in the finished oil; and (b) asphalt, which may occur in dark cylinder oil, where its presence is undesirable.

In addition to the hydrocarbons, small amounts of oxygen, nitrogen, and sulphur, and in some materials helium, are also present. Sulphur, which may occur within the limits of 0.01 to 5 per cent, is a cause of considerable trouble to the refiner, and an important part of refining practice is its removal, or its conversion from one type of sulphur compound to a less objectionable one.

Possible combinations of carbon and hydrogen are legion. The science of organic chemistry is based on the compounds of carbon; and, by synthesis, many thousands of new combinations have been produced, leading to remarkable new products, and the promise of many more. In oil, this variety of carbon-hydrogen combination also plays an important rôle, for on it depends the type of crude oil produced.

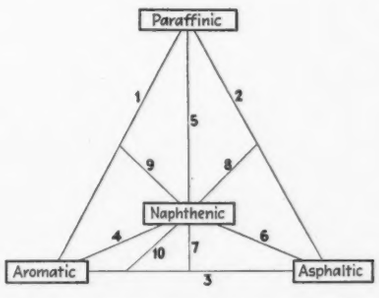
In one of the best-known methods of nomenclature, crude oils are roughly divided into paraffin-base, asphalt-base, and mixed-base petroleums. A fourth class has been suggested to be known as a hybrid-base petroleum. This would include naphthenic oils that carry a small amount of wax.

Paraffin-base crudes in their lighter fractions contain paraffin hydrocarbons, and these crudes are also characterized by the presence of 2 or 3 per cent of paraffin wax. Pennsylvania and Ohio are important sources of paraffin-base crudes. Asphalt-base crudes contain a considerable quantity of asphalt, and petroleum of this type is found in California, Mexico, Texas, and South America. Mixed-base crudes containing paraffin wax and asphalt are found in Illinois, Kansas, Oklahoma, North Texas, and Persia.

This system of nomenclature, long in use, is well known, but it is general in nature. Gruse, in "Petroleum and Its Products," proposes a classification, based on the chemical constituents of the crudes, described as follows:

"Practically nothing is known of the composition and constitution of the less volatile constituents of any petroleum. Such informaion as is available shows that all crude oils are mixtures of various types of hydrocarbons. For this purpose the chief constituents are considered to be the paraffin, naphthene, and aromatic hydrocarbon series, and asphaltic material. The placing of several typical crude oils on a composition diagram based on the system mentioned in the foregoing is given in the diagram below.

"The naphthenes, occurring largely in all oils, are regarded as of most importance. The four main constituents can be placed on a diagram as shown, and mixtures can be shown by lines joining the constituents. For example, Line 1 describes a mixture of paraffins and aromatics; Line 2 a mixture of paraffins and asphalt; Line 3 a mixture of aromatics and asphalt, and so on. Line 10 represents a mixture of naphthenes with aromatics and asphalt, in which the aromatics predominate over the asphaltic constituents."




**Crude-Oil classification from "Petroleum and its Products," by William A. Gruse, McGraw-Hill Book Company, Inc.**

From the point of view of economics —the chief interest of user and purchaser of lubricating oils—the system of nomenclature to which attention has been directed is of value because certain series of hydrocarbons in petroleum are found to possess superior lubricating qualities. These qualities depend on the stability of the oil, often expressed as its ability to "stand up" under operating conditions. Stability in lubricating oils —resistance to chemical and physical change—is closely connected with the type of hydrocarbons it contains, and the premier position long held by paraffin-base lubricating oils, as reflected in their higher price, is due to the presence of stable paraffin hydrocarbons.

Quality of lubricating oils is affected by the refining methods adopted and the equipment used. Distillation under slight vacuum has been practised for many years, but high-vacuum operation has recently come to the fore. Vacuum distillation occurs under reduced atmospheric pressure, boiling being possible under these conditions at a subnormal temperature. Vacuum distillates are said to be superior to steam distillates in color and viscosity. They require less refining.

After distillation, the refining of lubricating oils by chemical methods is generally accomplished by treatment with concentrated sulphuric acid, followed by a water wash, then by treatment with caustic soda, followed by a final water wash, and air blowing to remove the last traces of water.

Less drastic refining methods are based on selective solubility. One of the best known of these is the Edeleanu process, in which liquid sulphur dioxide at low temperature dissolves undesirable constituents, and leaves the more stable hydrocarbons. Oils refined by this method are free from unstable or readily decomposable compounds, which tend to resinify. Consequently, such oils resist oxidation and are stable to a surprising degree. If properly treated, these oils are free from tar-forming constituents, and their acidity is almost nil.

Still another method is known as the contact process, in which the oil and a special adsorbent clay are agitated together, and the mixture is filtered. It avoids chemical neutralization, and washing and drying of lubricating oils, replacing all these manipulations with one operation. By this process high-grade

lubricating oil can be made that will meet any government or commercial specification for acidity. This is because the clay, if properly chosen and used at an appropriate temperature, will selectively adsorb organic acids and other impurities, and remove the color-forming constituents from the lubricating oil.

The most important property of lubricating oil is its viscosity, particularly its rate of change of viscosity with change in temperature. Ability of an oil to lubricate at operating temperatures and pressures depends on viscosity or body, which, if sufficient, enables the oil to separate the moving surfaces without itself being squeezed out, and thus the oil prevents metal-to-metal contact. Rise in temperature reduces viscosity, and the extent of this change in any given lubricating oil is known as the temperature coefficient of viscosity, or the temperature-viscosity gradient of that oil. Lubricating oils refined from different crudes vary considerably in their temperature-viscosity gradients. In general, paraffin-base oils are least affected by temperature change, and this is the leading factor in quality. Increased pressure causes increased viscosity. This explains why the oil film often remains intact, and prevents burnt-out bearings, even under extreme pressure caused by temporary overloading or by misalignment.

What yardsticks may be used to measure the quality of lubricating oils? Many are available, and they vary in importance according to the purpose for which the oil is to be used. Thus, a characteristic important by its presence in one material may be unnecessary, or equally important by reason of its absence, in another. An example of this is the great importance of demulsibility or resistance to emulsion in turbine oil or in steam-engine oil used in a circulatory system, as opposed to the need for emulsion formation in low-pressure steam-cylinder oil, and in cutting oil.

The object of judging quality is to decide on the best and most economical oil to use for a specific purpose. Valuable assistance in this particular may be obtained from the lubrication engineering departments of the leading oil companies. They maintain staffs of lubricating engineers whose work it is to study details of design, operation conditions, and means of lubrication—with a view to making correct recommendations.

However, it will be useful to consider yardsticks that may be used directly, and this prompts consideration of the temperature-viscosity gradient. The Texas Company has devised a viscosity-temperature conversion chart, to compare the gradients of different oils. Copies of this chart may be purchased from The Emil Greiner Company, 55 Van Dam St., New York; or from Keuffel & Esser Company, 127 Fulton St., New York. A general guide to the purchase of lubricants on the basis of specifications in the United States will be found in Bureau of Mines Technical Paper No. 323 B, "Master Specifications for Lubricants and Liquid Fuels," on sale for 15c. from the Superintendent of Documents, Government Printing Office, Washington, D. C. It covers specifications and methods of sampling and testing lubricants and liquid fuels used by the United States Government and its agencies. A guide to practice in the British Isles is found in Bulletin 210 (1924), "British Standard Classification of Pure Mineral Lubricating Oil," which may be purchased from the British Engineering Standards Association, 28 Victoria St., London, S.W. 1.

A valuable commentary on the "Significance of Tests of Petroleum Products" is furnished in a report submitted by Committee D-2, on petroleum products and lubricants, to the American Society for Testing Materials. This report, reprinted from the Proceedings of the A.S.T.M., Philadelphia, Pa., Vol. 28, Part I, 1928, may be purchased for 50c. It is a useful reference work for buyers of petroleum products. The following abstract from this report serves to indicate its value.

By way of introduction one reads that physical tests are more widely used than chemical tests, which is natural in view of the fact that the utility of petroleum products depends to a large extent upon their physical characteristics. Some of these physical tests are of little value except as they serve the refiner in controlling manufacturing processes; others are useful both to consumer and to manufacturer as an index of the value or fitness of products for particular uses. The proper choice of tests and the assignment of proper numerical values to specifications based upon these tests are of fundamental importance. Failure to meet such requirements tends to increase the cost of product to consumer, and adds to the burdens of the manufacturer. The purpose of the report is to meet the need for authoritative information regarding the applicability of the tests for petroleum products and lubricants now in common use in the United States, and the significance of the results obtained.

Three types of viscosity instruments are employed in commercial testing: one for light distillates, one for lubricating oils, and one for heavy fuel and road oils. Two or more instruments are available for each of these ranges. As viscosity changes rapidly with temperature, a numerical value of viscosity has no significance unless both temperature and instrument are specified.

The Saybolt universal viscosimeter (A.S.T.M. Standard Method of Test No. D 88-26) is now used generally in the United States for the determination of the viscosity of lubricating oils. On the lighter oils the measurements are made at 100 or 130 deg. F., and on the more viscous oils at 210 deg. F. The instrument gives reliable results at any temperature between 31 and 210 deg. F., provided the oil is not near its solid point or its flash point. Above 210 deg. F., radiation losses become so great that the results are not satisfactory, and recourse must be had to instruments such as the Ostwald type of viscosimeter, which can be completely immersed in a high-temperature bath. In addition to the Saybolt universal viscosimeter, other instruments covering the same general range, but not standardized by the A.S.T.M., are the Redwood Number 1, Barbey, and Engler viscosimeters. Inasmuch as the rate of change of viscosity with temperature varies with different oils, viscosity tests should in general be made at the standard temperature that approximates most closely the temperature of use. All other physical and chemical tests for petroleum products in general use are covered in the report, which has distinct value to engineers and purchasing agents who wish to buy petroleum products on specifications.

The testing of lubricants is a complicated matter. A few of the larger mining companies have equipped their laboratories with oil-testing apparatus, but the majority of companies rely on the oil refiners' specifications and tests. Under these circumstances, engineers and purchasing agents will be interested to know of quick and practicable methods of testing lubricants, without the use of special apparatus or the necessity of utilizing the services of an oil chemist.

Information of practical value as a guide to quality in lubricating oils may be obtained with little expense or effort. Gravity and viscosity tests on new oil disclose (a) the source of the crude petroleum from which the oil is made, and (b) the behavior to be expected from the lubricant under service conditions. These tests may be made by any intelligent person after instruction by a competent teacher.

The ultimate test of the quality of a lubricant is to be found in its behavior under service conditions. Thus, in comparing the performance of two or more lubricants, a simple method is to measure the frictional temperature rise of typical bearings, using first one oil and then another. Naturally, the oil is superior which maintains a lower temperature in the bearings under constant conditions of speed, load, and air temperature.

When a group of machines are driven by electric motors, measurements of the power consumption under constant conditions may be used to determine the superiority of one bearing oil over another. Also, if a dynamometer is available, measurements of the difference in power consumed by small machines using different lubricants may be used to indicate their comparative value.

The free revolution test is another method of comparing the lubricating qualities of different oils. A machine or a length of shafting is run at normal

speed; then the power is shut off, and a count is made of the number of revolutions until it comes to rest, which forms a rough basis for comparison of the performance of one oil against another. These tests, although not accurate, are suggested as practical shortcuts in testing lubricants. They usually furnish a general guide to quality of lubrication when regular oil-testing apparatus is absent.

Economies to be derived from the correct selection of lubricants have been studied by some of the major oil companies. One result is the system developed whereby lubrication contracts are made on the basis of tonnage output from mines and mileage operation on railroads. In these instances the cost of lubrication appears as a direct charge against the cost of power and operation of mines and railroads.

In his "Industrial Oil Engineering Handbook," J. R. Battle gives interesting figures relating to the savings effected by the proper selection and application of lubricants. He states that power loss from excessive friction in a prime mover may be as high as 20 per cent. By efficient lubrication this may be reduced to only 3 or 4 per cent in the operation of modern high-speed engines, and to 6 or 8 per cent in the older types of engines. Inasmuch as cost of power to the larger producer is about $15 per year per horsepower, and the cost to the small producer in some instances is about ten times that amount, the economic possibilities are obvious.

The same authority states that shafting losses often reach 60 per cent of the power transmitted, the average loss being 35 per cent. This loss can be reduced to about 10 per cent. Although correct alignment, ring oilers, and properly adjusted belting play a most important part in shafting-friction losses, experience has shown that such losses may be reduced as much as 40 per cent by adopting a more suitable lubricant.

Improved lubrication may also account for considerable savings in repair bills and in depreciation. Repairs may range from 5 to 25 per cent, and depreciation is commonly charged off at 20 to 30 per cent of the yearly power production costs. Increasing demand for noise reduction suggests further reason for greater interest in scientific lubrication as one of the lines of attack in the search for noise abatement methods.

Actual cost of good lubrication is trifling compared with the economies to be derived from an applied study of the subject. The value of making use of the guiding principles suggested is therefore evident when seeking lubricants that are definitely applicable for all industrial purposes.

■

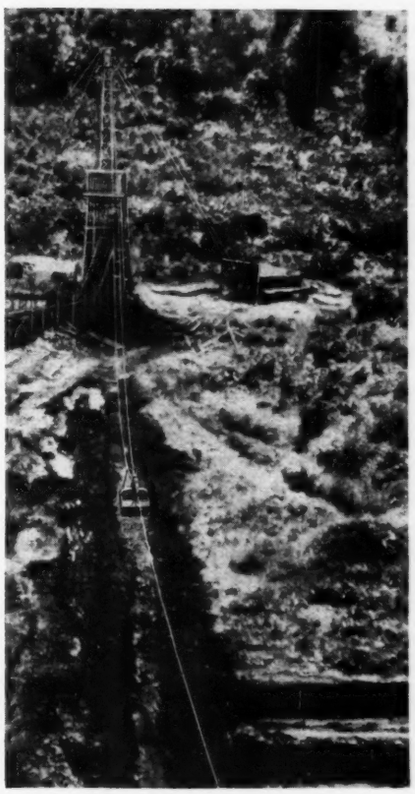
# Mining Gold Gravels in Sierra Leone

TWO placer gold-mining operations are being conducted in the jungles and hills of Sierra Leone, West Africa, by the Sierra Leone Goldfields, Ltd., subsidiary of Naylor, Benzon & Company, Ltd., of London, and by the K. M. Trust, Ltd., also of London. Both operations require the excavation of large quantities of the alluvial pay gravel. Despite the arduous overland journey from the nearest point of the motor road that comes up from the port of Freetown, both have recently installed slackline cableway to do the digging.

Naylor, Benzon & Company have mining rights to 75 acres and prospecting rights to 12 square miles along the Pampana River and the small stream called Makaki which flows into it. Some gold is found all over the terrain, but not everywhere in quantities that pay, and the deposit worked is in a valley between two ranges of hills. The topsoil contains little gold, but the pay increases in the gravel below, and the richest horizon is in the upper 2 ft. of the bedrock under the gravel, which is blasted. Total depth excavated varies from 10 to 25 ft.

To work this deposit, moving steadily up the valley, the mining company sets up its plant and the 1-cu.yd. Sauerman cableway excavator at one side of the valley, and from this point the cableway takes out all material within a semicircle across the valley and upstream and downstream for 600 ft. in all directions from the mast. Cableway and plant are then moved 1,200 ft. up the valley, with the cableway located so that a new semicircular cut of 600-ft. radius will just adjoin the former cut.

The gold occurs as small nuggets and smaller particles down to almost dust. It is separated by washing the dirt and gravel down a long sluice box made of steel pans 12 ft. long, 4 ft. wide and 2 ft. high, bolted together to make a flume 200 ft. long. The cableway bucket discharges its load against a splashboard at the upper end of the flume, about 50 ft. above the ground level, and the water is fed in near by. On the flume bottom is a rough wire screen, on top of which are transverse cleats, such as pieces of rail, to trap the gold when it sinks to the bottom. The men with rakes are employed on the flume to rake the dirt, sand, and stone along. Every ten to fifteen days the washing is stopped long enough to clean out the accumulated pay dirt. This is then rewashed in a sluice box 1 ft. wide and 15 ft. long, and the material so refined is washed by hand in steel pans.



**Excavating gold-bearing gravel with slackline cableway in Sierra Leone, West Africa**

Water for the washing is taken from the river. To get the proper elevation the intake is located about 2 miles upstream and the water flumed to the plant. The company has an electric-light plant, which, though small has been successful and makes it possible to run the plant two shifts a day. This is the only electric plant in Sierra Leone outside of Freetown. Even the houses for the native workmen are equipped with electric light.

About fifty natives are required for the work. Natives are also employed as personal servants and as porters for carrying machinery and supplies over the 12-mile stretch between motor road and camp.

The plant of the K. M. Trust, 50 miles away, is in general like the plant just described, except that a smaller cableway (a 13-cu.ft. Sauerman "Junior" outfit) is used, supplemented by a ½-cu.yd. Sauerman "Crescent" scraper which strips the overburden. Some of the mining is still done by hand, about 350 blacks being used for the work, some of them breaking the ground with picks, others loading it with shovels into small steel pans, and still others carrying these pans on their heads to the sluice box—for a shilling a day.

# Employee Housing—I

**A. H. Hubbell**
*Associate Editor*

EMPLOYEE housing has two aspects; that of a necessity supplied perforce if the mining company furnishing it is to operate its mine or plant; and that of welfare work, for the purpose of making the employee more contented, and, consequently, more efficient. An employee can live in a shack, with few facilities for his own or his family's comfort, if he has to do so, and without any sense of grievance against the company for whom he works, if only he be the owner or rents the dwelling independently of his employer. But let the latter be guilty of providing inferior quarters and the situation becomes materially changed, the conditions now tending to breed unrest and discontent and to increase labor turnover. That this is well recognized is attested by the fact that most companies today give the matter of housing the attention it deserves. In some instances they have taken unusual pains to make their workmen comfortable.

**Five-room brick house, Roan Antelope Copper Mines. Drawings shown in Fig. 1**

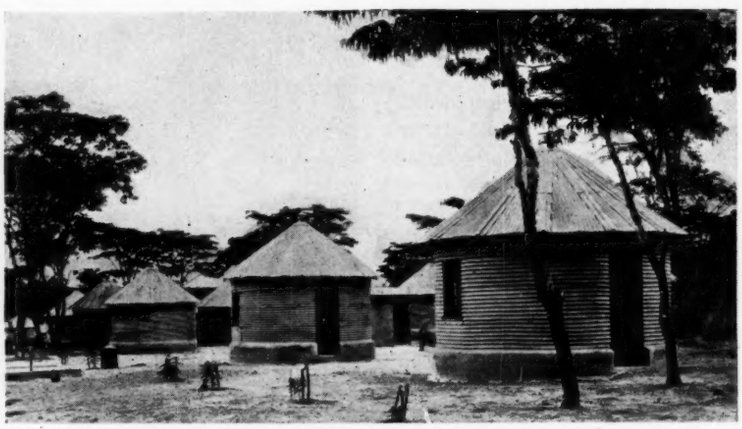
Comparisons of the types of housing provided in different localities and climates are informative, especially to an individual charged with the necessity of deciding what shall be built in a region in which he has previously had no experience. Primarily for the benefit of such a reader, as well as to summarize what might be called the best existing housing practice, have the data, drawings, and other illustrations presented in this article been brought together. Space limitations have compelled the presentation of the drawings on a much reduced scale, with resultant omissions of various useful details, which, however, is compensated for as far as possible in the adjoining text. Publication of this material is possible through the courtesy of the companies whose housing is described. These are (1) the American Metal Company and its subsidiaries—namely, the Cia. Minera de Peñoles, the American Metal Company of New Mexico, and the American Zinc & Chemical Company; (2) Roan Antelope Copper Mines, Ltd.; (3) Minas de Matahambre; (4) Chile Exploration Company; (5) Hudson Bay Mining & Smelting Company; (6) Phelps Dodge Corporation; (7) United Verde Copper Company; (8) Texas Gulf Sulphur Company; (9) Nevada Consolidated Copper Company; (10) American Potash & Chemical Corporation; (11) Utah Copper Company, and (12) Anaconda Copper Mining Company.

Which of the types of construction used in the houses to be described is best for any given locality and climate this article will not attempt to affirm. To do so would presuppose a knowledge not boasted by the writer. Moreover, anyone attempting to compare and generalize as to climate will find difficulty in any classification that may be adopted. Data as to precipitation and temperature are likely to be misleading, although both should be known. Equally misleading may the geographical location of any particular region be, unless altitude and other factors are considered. The best that one can do, if one has never lived in a locality for which housing is to be provided, is to study the methods and materials used in other regions, and to get the opinions of those who have had experience with them.

The localities in which are situated the structures embodying the types of housing to be described are as follows:

Luanshya (Roan Antelope)—Northern Rhodesia
Newgulf—Gulf Coast, Texas
Matahambre—Pinar del Rio, Cuba
Achotla—Guerrero, Mexico
Monterrey—Nuevo León, Mexico
Pecos Mine—Upper Pecos Valley, New Mexico
Tyrone—New Mexico
Jerome—Arizona
Trona—California
Chuquicamata (and Tocopilla)—Chile
Ruth—Nevada
Copperton—Utah
Conda—Idaho
Langeloth—Pennsylvania
Flin Flon—Northern Manitoba

Factors affecting the comfort of employees, and which therefore must be taken into consideration in selecting materials and deciding upon design, include extremes of heat, cold, rain, humidity, and the length of period for which they prevail; also the prevalence of termites and other pests destructive to building materials or annoying or in-



**Kator huts, Roan Antelope Copper Mines. See Fig. 2**

jurious to the occupants of the dwellings. Of importance also where families are to be housed, although subordinate to the question of construction and materials, are the number and arrangement of the rooms to be provided in a dwelling. On this count, especially, the floor plans here presented should prove useful.

A question preliminary to those factors attendant upon the character of housing to be provided is whether or not housing is desirable or necessary in the first place. In instances where mine or plant is remote from any civilized community, this question will naturally answer itself. Some mining enterprises, however, are conducted within easy reach of communities where employees can readily find adequate housing accommodations at a reasonable cost—this owing commonly to the possession of an automobile by the employee or to the existence of convenient bus, street car, or other transportation. Such facilities are common in the Lake Superior Iron Country today. In this region, housing facilities have been supplied by many of the companies in the past. The general manager of one of these companies, which has many houses to maintain, recently stated that his company would be better off without the houses, generally speaking. The rentals in general did not meet the fixed charges. To build houses was, under most conditions, he thought, a great mistake. In a new locality the situation is different. Employees cannot be expected to build or buy houses. Today, this executive thought, if a company were starting a mine within reasonable transportation distance of an already settled community, it would find it cheaper to transport its men to and from their work. In general, one may say that the provision and maintenance of housing will be an important item of expense, and, so far as rentals are concerned, is almost sure to prove a source of loss. The only question is whether or not the advantages to be gained will justify the loss.

Where conditions necessitate provision of housing for employees, the first question to be decided is whether this housing is to be of a permanent or temporary character of construction. This, of course, will depend on the prospective length of life of the enterprise. In no circumstance is flimsy construction justified, save where the project is of the most temporary sort, for such construction will otherwise mean high maintenance cost and is likely to be a breeder of discontent.

On the decision as to whether or not the housing shall be permanent in character will depend the materials used for construction. For construction in remote localities, everything may possibly have to be brought into the district from a distance, with certain exceptions as where the enterprise is large enough to warrant the erection of a sawmill or brick plant at the start, or where adobe dwellings are to built, as in parts of Mexico; or thatch roofs will suffice, as in parts of Africa, or where log houses are to be constructed, as has been done at times in parts of Ontario and Quebec. Where construction is to be of a character so permanent as to call for the use of hollow tile, sheet metal, cast iron, and cement, as well as various materials used for insulation, such supplies will generally call for importation from a distance, with consequent increase in cost.

In any but the mildest climate the matter of insulating against loss of heat

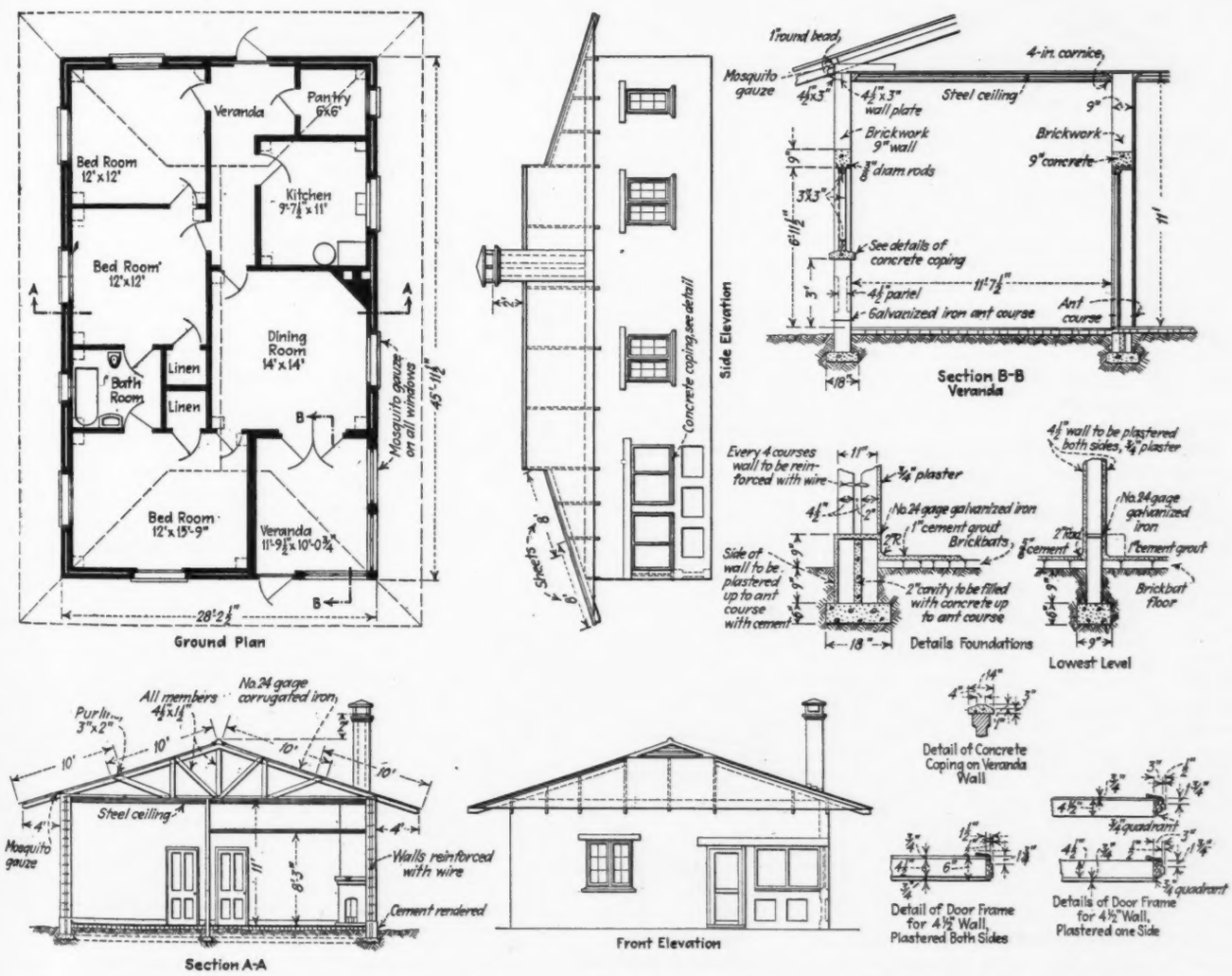



**Fig. 1—Floor plan, elevation and details of five-room brick house, Roan Antelope Copper Mines, Ltd., Luanshya, Northern Rhodesia**

or against excessive outdoor temperatures is in general worthy of far more attention than it has usually received. In the specific instances to be cited and described in the following, the reader will note that at times due attention has been given to insulation and, at others, it has been seemingly ignored, although without good reason. Wherever climatic conditions require the occupant to burn fuel to heat a building, the use of insulating material of one sort or other in outer walls will be almost certain to be reflected in a marked reduction in quantity of fuel consumed. In this connection may be cited the interesting case of a dwelling in a Western town that was insulated so much better than the surrounding homes against loss of heat in winter that it was the only building in the vicinity on the roof of which the winter snow remained without melting throughout the season. Here, I may add, the additional insulating value of the snow itself was utilized. Likewise, in climates that are intensely hot, properly insulated outer walls and roofs will permit the maintenance of comfortable interior temperatures. Readers interested in the subject of efficient insulation of mining camp dwellings can do no better than refer to the articles by James Govan and the late Harrison E. Clement, which were published in these pages in the issues of Feb. 16, March 2, and March 16, 1929. The subject of house insulation, principally with respect to the use of wood and its byproducts, is also dealt with in a bulletin recently issued by the U. S. Department of Commerce.

Whether or not a mining company should erect its houses itself or contract to have this done will depend largely on the availability of an adequate supply of skilled labor. Where this is lacking, so that it also must be brought in along with the materials and supplies, the most convenient and probably the cheapest course to pursue will be to advertise the job for bids. In this connection, the possibility of using portable houses, supplied ready-cut with all parts numbered, so that they can be erected by common labor under proper supervision, should not be overlooked.

With the foregoing general summary as an introduction, the housing facilities in the various districts mentioned earlier in the article will be described successively with illustrations.

*Roan Antelope Copper Mines, Northern Rhodesia* — The Roan Antelope mines are situated at Luanshya, in Northern Rhodesia, a sub-tropical country. Although the location is only 12½ deg. south of the equator, the climatic conditions are ameliorated by reason of the altitude of the region, which is 5,000 ft. above the sea. The average maximum temperature in summer is 97 deg. and in winter 90 deg. Throughout ten months of the year the nights are relatively cool, and during the winter months of June and July temperatures as low as 40 deg. F. may be expected after sundown. The rainfall, averaged over a period of three years, is 51 in., all of which is precipitated during the five months of November to March inclusive.

The design of the company's houses has been materially affected by the necessity of protecting the occupants

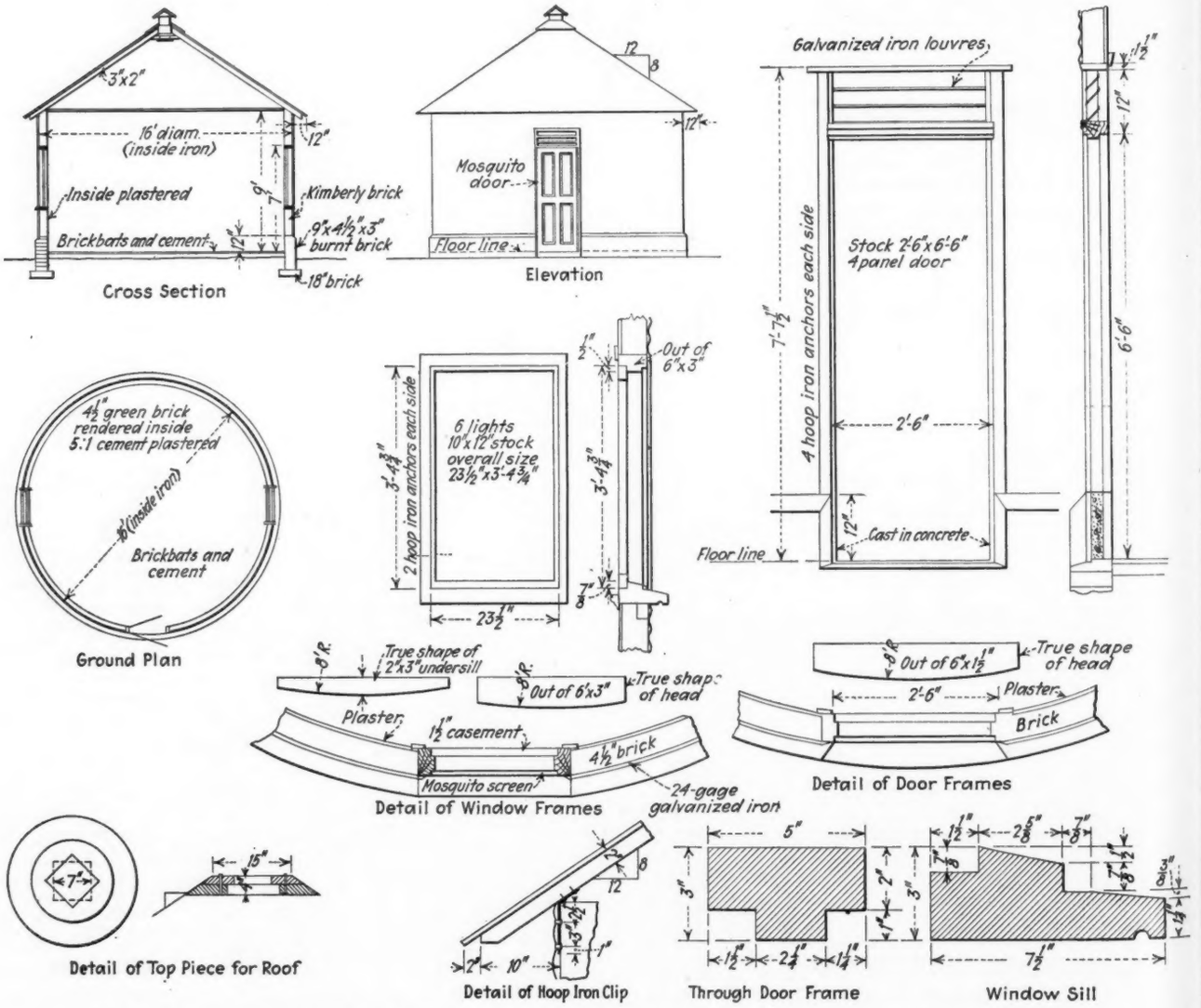



**Fig 2—Ground plan, elevation, cross-section, and construction details of Kator hut provided for unmarried employees, Roan Antelope Copper Mines, Northern Rhodesia**

against termites, or white ants, mosquitos and other flying insects prevalent in the region. This will be noted at once in the drawings of the two types of housing here reproduced. The originals of these drawings were received from Mr. James A. Shepard, assistant general manager at Luanshya, with the kind consent of Dr. Otto Sussman, in New York, and Mr. A. D. Storke, the company's managing director in London. Fig. 1 shows a house typical of those allotted to married white employees, both those on the staff and those employed on day's pay. Fig. 2 shows the so-called Kator hut, which is the typical dwelling used for housing unmarried employees.

The foundations of the house illustrated in Fig. 1, which house, incidentally, is shown in a rather attractive setting in one of the accompanying photographic reproductions, are of burnt brick resting on a concrete footing, the bricks being rendered with a coat of cement plaster. This foundation is carried six inches above the floor level.

The floors are of concrete or of cement grout one inch thick, underlaid by bricks which are laid directly on well-rammed ground. Concrete or grout is poured tight up to the foundation, so that it forms a solid cement raft through which the white ants cannot penetrate. On top of the foundation wall, as a further protection against the white ants, a so-called "ant course" is laid. This consists of a strip of 24-gage galvanized flat iron sheeting that is one inch wider than the thickness of the wall. This may be seen in Fig. 1 as well as in the photographic print.

On top of this course are laid the burnt bricks[1] forming the walls of the house. These bricks are made locally. The outer walls of the house are 11 in. thick and are of the cavity type, having a 2 in. dead-air space in the center save where the wall is cut by windows and doorways. The brick wall on either side of this air space is 4½ in. wide, the two walls being reinforced and tied together with wire every four courses vertically. Below the ant course the 2-in. air space between the walls is filled with concrete. Above the ant course only the inner face of the inside wall is rendered with plaster, as one of the details of Fig. 1 shows. The interior walls or partitions between rooms are of brick and 4½ in. thick. Each face is given a ¾-in. coat of plaster, which is then rendered (coated) with calsomine. Verandah walls are 9 in. thick.

All door frames, window frames, and sashes are of wood. All window openings and outside door openings, as well as the verandah, and especially the space between the wall plate and the roof, where the eaves project beyond the walls, are guarded against the entry of mosquitos and other insects by means of mosquito gauze. The door frames are anchored to the wall with hoop iron. The windows are 3 ft. 3 in. above the level of the floor and have each six 10x12-in. lights or panes. Window sills and the lintels are of concrete.

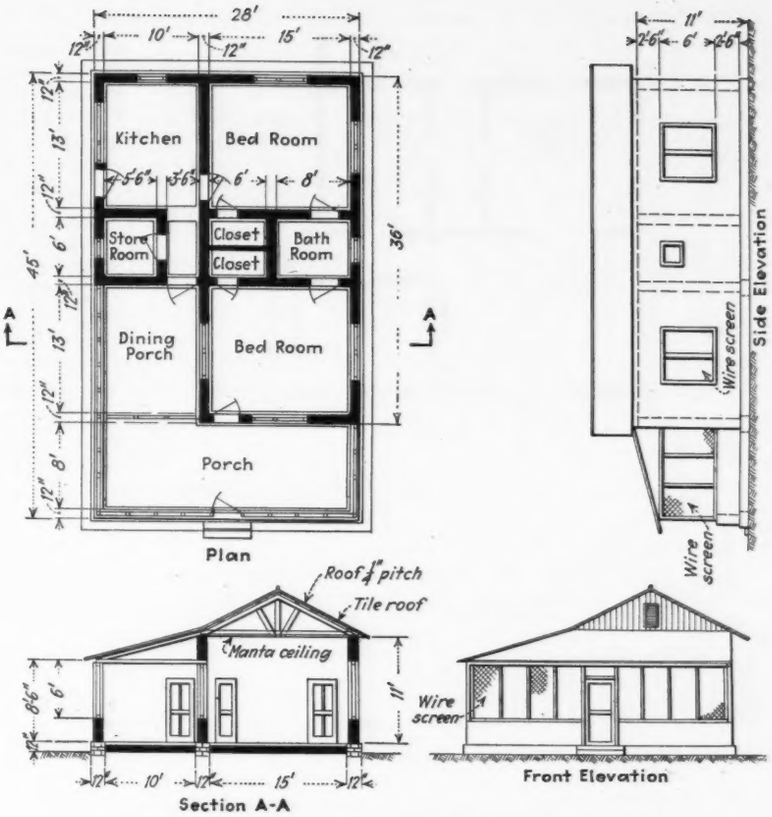



**Fig. 3—Floor plan, elevation, and section of dwelling furnished married white employees at Temisco mill of Cia. Min. de Peñoles, Achotla, Guerrero, Mexico**

The rooms of these houses are 11 ft. high from floor to ceiling. The ceiling consists of pressed-steel ceiling sheets. In the corners of the ceiling in each room ventilators are provided to insure adequate movement of the air. Wall plates are secured with hoop iron.

Roof framing is of timber and the roof covering of galvanized corrugated iron. On all four sides the house is protected against heavy rains and against the heat of the sun by the wide eaves, which project 4 ft., measured horizontally, beyond the wall on each side. The eaves help considerably in keeping the house cool during the heat of the day.

The appointments of the house can be readily seen from Fig. 1. Both bathroom and kitchen are provided with running hot and cold water. All rooms are equipped with electric light. Each house is connected to a water-borne sewage system.

The average cost of this type of house, including a one-room native servant quarter, and connection to sewer, water, and electric mains, was £900, according to Mr. Shepard.

The Kator hut, shown in Fig. 2, as well as in a photographic reproduction, is built in blocks of sixty. Each block includes six lavatory blocks and one central bathroom which is fitted with shower baths, lavatory basins, toilets, and the like, all connected to the sewer.

As the illustrations show, the Kator hut is a cylindrical shell of galvanized corrugated iron. 16 ft. in diameter and having a conical roof, also of the same iron, which is carried on 3x2-in. wood rafters. Fourteen rafters are required, spaced at equal distances on the side wall, to which they are secured by a good quality of hoop iron. Twelve-inch galvanized iron ridging is fixed over each rafter. Other joints are secured with ¼x¾ in. verandah bolts and nuts. The iron roofing is attached to the rafters with galvanized-iron screws and lead washers.

The hut is set on a foundation of burnt brick, which is carried 12 in. above the level of the floor, this foundation being rendered with cement plaster. Bricks used in the construction noted are laid directly on earth that has been well rammed and watered. The floor is of concrete and the interior of the cylindrical shell is lined with bricks 4½ in. thick, which are plastered. The room thus constructed is ceiled with canvas tacked to the rafters with ⅞x1⅛ in. beading. In the apex of the roof a ventilator is provided. As is indicated in the drawing shown in Fig. 2, the two window openings and the door openings are protected against the entry of mosquitos by gauze.

The cost of one of these huts is £60.

[1]Additional information regarding the dwellings shown in Figs. 1 and 2 will be given in Part II.

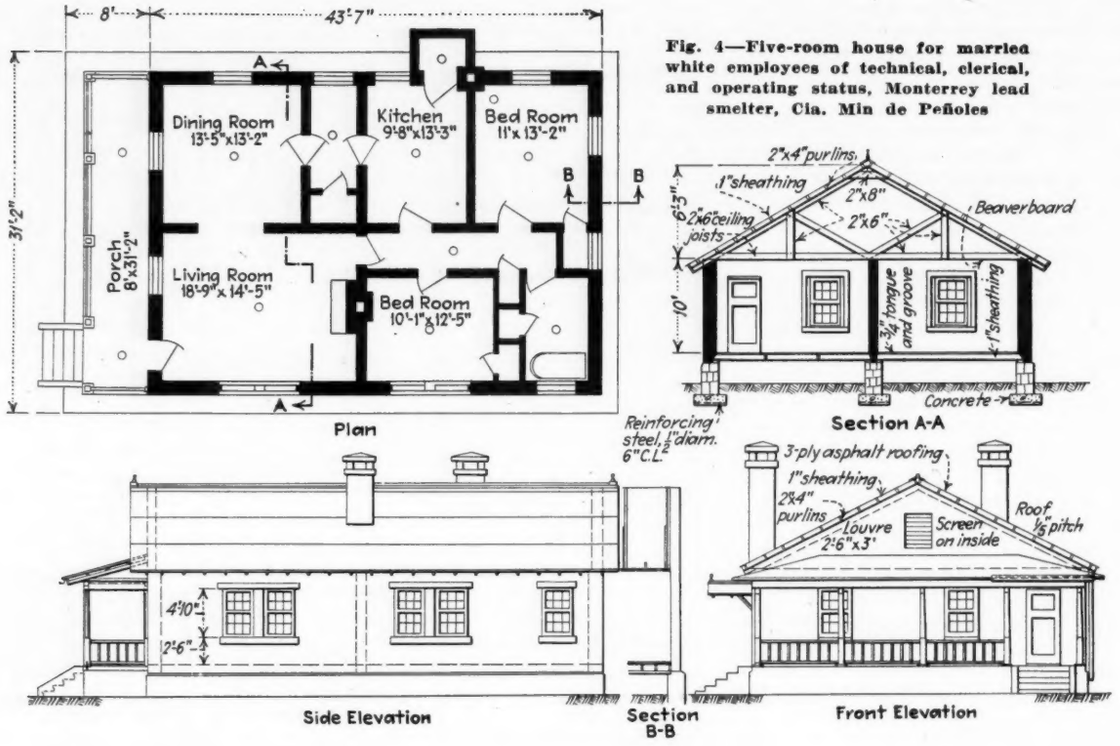



**Fig. 4—Five-room house for married white employees of technical, clerical, and operating status, Monterrey lead smelter, Cia. Min de Peñoles**

*Housing at the Peñoles Company's Mill, Achotla, Guerrero, Mexico*—Fig. 3 shows the dwelling supplied by the Cia. Min. de Peñoles for married white employees at its Temisco mill, at Achotla, in Guerrero. Specifically, this house is supplied to the mill superintendent and the master mechanic. Its approximate cost is given as $2,000.

Climatic conditions at Achotla are semi-tropical, thanks to the elevation, which is 570 to 700 m. above the sea. Maximum temperature is on the average 100 deg. F. The humidity is high. The figure as to the average precipitation is not available. Adequate provision for a rainy season, lasting from June to October, must be made.

Foundations for these houses are of stone masonry. Adobe is used for the outside and inside walls, those of the outside being plastered on both sides. Floors are of concrete, and the ceilings of manta, or cloth. Burned clay tiles are used for roofing. Porch and windows are enclosed in wire screen. No insulating materials are used. Electric light is provided, and running water is piped to kitchen and bathroom, the latter having tub, shower, lavatory, and toilet. The commodious front porch is used as a living room throughout the year.

*Housing at Peñoles Company's Lead Plant, Monterrey, N. L.* Monterrey is 534 meters above the sea. Average annual temperature is 71½ deg. F., and the average precipitation only 20.25 in. Fig. 4 shows a five-room house provided for married white technical and operating employees at the Peñoles company's lead smelter and refinery. Fig. 5 shows the so-called "bachelors' mess," or quarters for unmarried white employees of technical, clerical, and operating status.

One-family houses as illustrated in Fig. 4 have a foundation of rubble masonry with a reinforced concrete footing. Outside walls are of slag brick, unplastered. Caps and lintels are of concrete reinforced with three ⅜-in. rods. The inside, or partition, walls are of hollow brick. Floors are made of ¾-in. tongued-and-grooved pine laid on 1-in. sheathing, except in the kitchen, pantry, and bathroom, where they are of tile. The ceilings of the rooms are of beaver board. Roofs are of three-ply asphalt roofing.

The threshold of the front entrance is of concrete. Front and rear doors are 3x7 ft. x 1½ in. in dimensions; those leading into individual rooms are 2 ft.

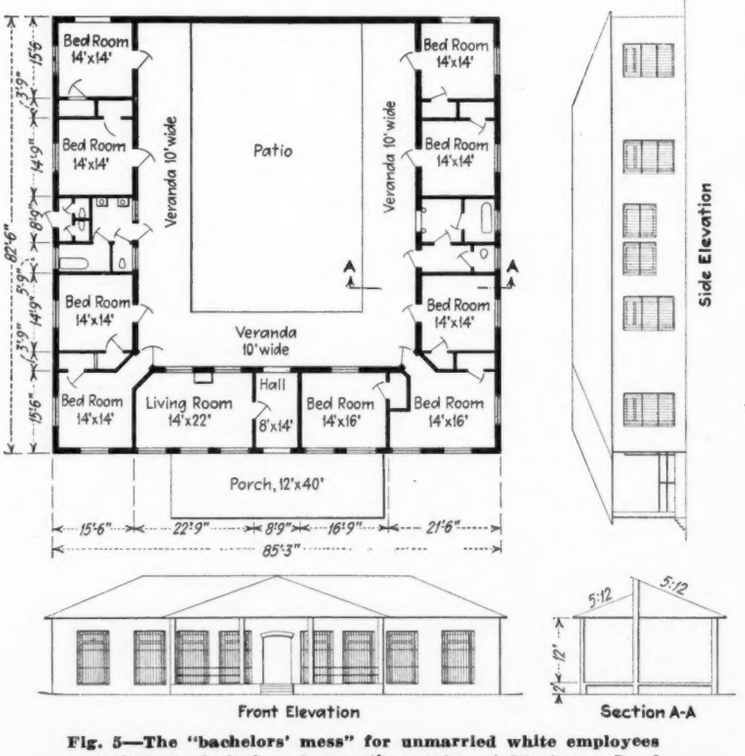



**Fig. 5—The "bachelors' mess" for unmarried white employees of technical, clerical, and operating status at Monterrey Lead Smelter, Cia. Min de Peñoles**

8 in. x 6 ft. 8 in. x 1½ in.; and closet doors are 2 ft. x 6 ft. 6 in. x 1¼ in. The front door is provided with a glass panel, 18x27 in. and a transom above having one 32x13 in. light. These houses have no cellar, as the drawing indicates.

The bachelors' mess, shown in Fig. 5, provides nine rooms, each 14x14 ft. in dimensions, arranged on three sides of a hollow square, with a bathroom in the center of each side wing. In addition, a general living room, 14x22 ft. in dimensions, is provided at the left of the front entrance hall. Looking on the patio inclosed by the two wings is a 10-ft. verandah, which runs around the three sides. Other details are shown on the drawing.

In this building the foundation is of rubble masonry. Outside walls are of sillar faced with red brick, and the inside walls of red brick, plastered and painted. Floors are of concrete. Ceilings are of tongued-and-grooved pine, having a layer of coke dust above them for protection against the heat transmitted through the roofing, which is of galvanized iron. No insulation against heat is provided other than this.

The house shown in Fig. 4 is piped with running water in kitchen and bathroom and is equipped with electric light and with natural gas for heating. The bathroom is furnished in the customary manner with tub, lavatory, and toilet. Bachelors' quarters, Fig. 5, are likewise equipped with running water in the bathrooms, which have tubs and showers, lavatories, and toilets. The building is also wired for electric light. The general living room shown in the drawing is provided with a fireplace and electric heating.

As estimated, the cost of building the five-room house shown in Fig. 4 was $4,319, Mexican currency. The cost of the bachelors' quarters was, of course, considerably more, the actual figure being $28,364.20, Mexican currency.

*(To be continued)*

■ ■ ■

# Compressed Air Supervision an Engineering Task

**Peter Erimescu**

THE use of compressed air in underground operations has recognized advantages, but serious trouble is unavoidable, and losses are extraordinarily high in the absence of capable supervision. Generally, air lines and connections are installed and maintained by the mechanic; seldom are they controlled by an expert. Air lines, however, should be designed with almost the same care as lines for electrical transmission.

Losses from leakage are to some extent an avoidable waste, and investigations of this factor of inefficient operation have shown that in a mine with a well-designed and controlled compressed-air plant, leakage losses can be minimized. But other factors influence efficient power transmission by compressed air. Friction losses in the air lines, with their tees, bends, elbows, and reducers, in valves of unsuitable design, and corroded parts, constitute a serious element in uneconomic operation, and, if a skilled expert is not at hand, a source of low efficiency.

The allowance in drop of pressure, varying from half an atmosphere to 2 atmospheres, is calculated on the basis of the compressed-air supply needed by the air-driven tools and engines. This drop must be distributed proportionately in each section of the mine, thus keeping air velocities within reasonable limits. For the design of air lines, the following formula which has been proved by numerous investigations, according to Flottmann, allows correct calculation for smooth-bore pipe:

$$p' = \frac{k \,.\, s \,.\, w^2 \,.\, l}{10.000 \,.\, d}$$

Where $k$ = factor of multiplication (see Table I); $s$ = weight of 1 m³ of compressed air at the given pressure; $w$ = velocity of air in the air line (m/sec.); $l$ = length of air line (m); $d$ = diameter of air line (mm.).

**Table I—Factor of Multiplication**

| Weight of Air-Flow in the Air Line, Kilograms per Hour | Value of $k$ |
|---|---|
| 25,000 | 0.64 |
| 15,000 | 0.69 |
| 10,000 | 0.73 |
| 8,000 | 0.75 |
| 6,000 | 0.79 |
| 4,000 | 0.83 |
| 2,000 | 0.93 |
| 1,000 | 1.04 |
| 500 | 1.16 |
| 250 | 1.26 |

Every kilometer of air line in the mine contains from 25 to 30 valves, cocks, bends, or tees, and other fittings that cause pressure drop. The equivalent resistance of such fittings in terms of straight piping is given in Table II.

**Table II—Resistance Criteria**

| Diameter of Air Line, Millimeters | Bends, Cocks, Meters | Tees, Meters | Valves, Meters |
|---|---|---|---|
| 20 | 0.3 | 2 | 6 |
| 50 | 1.0 | 5 | 16 |
| 100 | 2.0 | 10 | 38 |
| 150 | 3.5 | 18 | 65 |
| 200 | 4.5 | 23 | 91 |

The assumption is general that compressed air, issuing from the compressor at about 110 deg., C., loses pressure as well as temperature during its flow through the air line. This is true for air in closed vessels, but not in air lines, where the outlet is continuously replaced. The principal causes for drop of pressure are as follows:

If air consumption increases suddenly, the compressor can meet the demand only after a certain time, depending on the size of the compressor and the manner of regulation. During this time a part of the air used is taken from the lines. The air expands and its pressure must drop.

A second cause for pressure drop is seen in the fact that machines with air-driven pistons cause, by the changing velocity of the piston, a changing in the velocities of air in the pipes. The air lines are designed for a certain air flow at a certain constant velocity. But the maximum velocity of air influences the drop of pressure. The push-like movement of the air requires, furthermore, a certain amount of power, to give for every stroke of the engine the adequate acceleration to the air. This power, which must be furnished by the air pressure, can reach extraordinarily high values and often causes a heavy drop of pressure. Using the following formula, the power required for the acceleration of the air can easily be calculated:

$$p_a = \frac{a \,.\, l \,.\, p \,.\, 1.2 \,.\, 0.0001}{9.81} \cdot \frac{(D)^2}{(a)} \text{ or}$$

$$p_a = \frac{1.22}{100,000} a \,.\, l \,.\, p \,\frac{(D)^2}{(a)}$$

where $p_a$ = power for acceleration of the air (a.t.m.); $a$ = acceleration of the piston (m/sec.); $l$ = length of the connecting pipe (m); $p$ = absolute pressure of air (atm.); $D$ = diameter of the piston (mm.); $d$ = diameter of the connecting pipe (mm.).

The high value the drop of pressure can reach due to the foregoing detailed phenomena may be proved by observation of the fact that a hose of 10 m. length and 20 mm. diameter, as it is used commonly for hammer drills, can cause a pressure drop of about ½ atmosphere. To prevent or at least to reduce the drop of pressure may be easily effected. Greater diameters of the connection pipes and correctly placed air chambers, of sufficient size at the engines, will accomplish the desired result; but correct installation and careful control by experts are, primarily, the essential factors in efficient operation.

# The Gold Supply Increases

S. D. Strauss

*When Great Britain abandoned the gold standard in September, 1931, there was some talk of the possibility of gold becoming valueless. Shares of gold-mining companies were sold on the assumption that Great Britain's action might become general and that, if all countries abandoned the gold standard, the gold mines would have no market for their product. These fears were needless. Gold, even though it may not be used internally, is still the one commodity that can settle international balances of trade. Countries that are off the gold standard expect eventually to return to it. Gold mines are still assured of a limitless market at a fixed price for their entire output. Gold mining today is a prosperous and expanding industry. Dividends are increasing; new mines are being developed; new mills are being built, employment is afforded directly to several hundred thousand workers; support for mining communities numbering millions is assured.*

GOLD production continues to increase. In a world of stagnant trade it is probably the most important factor now making for economic recovery. Not only does increased gold production mean additional employment and additional profits circulating throughout the entire industrial structure, but it also adds to the metallic base on which the world's currency system rests. Many dire prophecies have been made in the last two years about a decline in the supply of new gold which would prevent further expansion of industry. Estimates have been made that a steady increase of 2 per cent annually in the gold supply is necessary for a corresponding expansion in the volume of world trade. In 1931 gold production was at least 1,000,000 oz., or about 5 per cent, higher than it was in 1930. And 1932 will show another increase. Early returns indicate that 1932 may even surpass the record year of 1915, when 22,737,520 oz. of gold was produced.

I have said that the world's currency system rests upon gold. It is true that two important countries are on a silver-standard basis and that in the last few months more than a score of countries have been forced to suspend redemption of outstanding paper currency in gold. However, being off the gold standard does not mean necessarily that a country regards gold as having less value. In fact, the value of gold, measured in terms of the depreciated currency, has risen. The countries that are off the gold standard continue to buy gold. International trade is still done on a gold basis and settlements are made by shipments of gold.

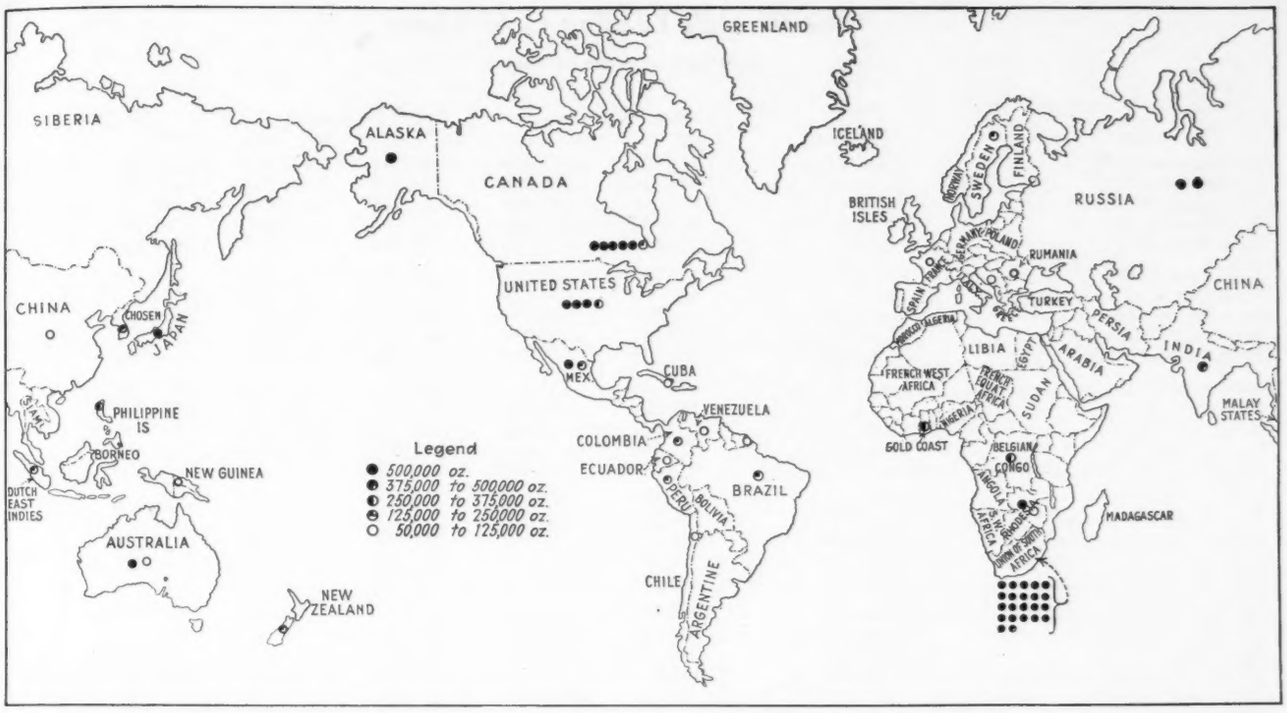
Gold has been so much discussed recently, that repetition of the outstanding facts about this precious metal would appear to be virtually unnecessary. Countries that are on the gold standard declare that a certain weight and fineness of gold is interchangeable for a certain unit in their currency systems. Thereafter they use supplies of gold to insure the value of their currencies. Because gold itself is not used in trade, but is replaced by more convenient paper currency, a country can safely issue currency amounting to double or triple its gold reserve. In addition, such banking devices as checks, notes, mortgages, and bonds make possible a volume of business immensely greater than the total sum of gold available. The monetary supply of gold has been estimated at between $11,000,000,000 and $12,000,000,000. The annual business of the world. even in times of depression, is probably twenty times that amount.

However, the entire new gold production is not added to the monetary supply of the world. A considerable portion goes into industry and the arts and another large fraction is absorbed by the Orient. India alone has taken about 3,000,000 oz. of gold annually, or about 15 per cent of new production in each of the last thirty years. This gold goes into peasant hoards, and, so far as the financial structure of the world is concerned, it might as well never have been mined. The amount that is available for new minting each year, therefore, is normally about 60 per cent of total mine production.

Obviously, if all new gold production could be added to the monetary supply, worrying about the metallic basis of Occidental currencies would be unnecessary at present. The depression has had a salutary effect on the use to which new gold is put. Industrial consumption dropped 10 per cent between 1929 and 1930. In 1931 it undoubtedly dropped still more. Furthermore, because of the lowered price of raw materials and the consequent diminution in the favorable trade balance of India, the amount of gold that could be absorbed by that country in 1930 was materially lessened. Imports of gold into India dropped 15 per cent in 1930. If only 60 per cent of new mine production went into the monetary reserves in 1929, it seems probable that about 65 per cent was available in 1930, and not less than 70 or 75 per cent in 1931.

When Great Britain went off the gold standard in September, 1931, India also went off. At that time it was considered that the step was a necessary evil. Events may yet make it an immense boon to trade. Abandonment of the gold standard has meant the discovery of a huge source of gold supply. Since last September, about 7,000,000 oz. of gold has been made available for monetary backing that was formerly contained in Indian hoards or British art. This is how it happened: After going off the gold standard, the price of gold in Great Britain rose. Instead of paying 84s. 10d. per ounce, English bankers had to pay from 110 to 120s. per ounce in depreciated currency. At first, the increased quotation for gold had no particular significance to the layman, but gradually owners of gold-bearing objects realized that they could dispose of those objects for a price that was nominally above their intrinsic value. Retail prices have not gone up appreciably in England or in India, and 110s. today will buy more than 84s. could have bought in September. Bullion merchants from Bombay have been scouring the richer provinces of India, buying huge quantities of jewelry and coins at prices that appear to the Indian peasants to be materially higher than those which they paid for their hoards. Altogether, about £41,000,000 in gold has been shipped from India, an additional £5,000,000 or so having been obtained in England.

This process will not continue interminably. Either India and Great Britain will once again anchor themselves to gold—perhaps at a lower level than formerly—or retail prices will rise gradually to a point where there will be no advantage in selling gold for depreciated currency. In either case, the flow of gold is likely to come to a halt. But even the addition of 7,000,000 oz. is an important contribution to trade. And the prospect that a larger percentage of the new production will go to monetary reserves in the future is




**Distribution of current gold production is shown on this map. The legend shows the quantity of gold which the various symbols represent. The basis is annual production.**

another encouraging sign for industry.

I have said that 1932 may see more gold produced than any previous recorded year. What basis is there for that statement? In 1931, production was about 21,300,000 oz., so that to establish a record, the increase in 1932 will have to be at least 1,450,000 oz., or about 7 per cent. Where will this increase come from?

South Africa, with its remarkable Witwatersrand field, produced a slightly lower percentage of the world total in 1931 than in 1930. The increase in South African output last year was 155,000 oz. to a total of 10,874,145 oz., which is 51 per cent of the 1931 world output. In 1930, Transvaal output was 53 per cent of the total. There have been many predictions that the Witwatersrand district cannot continue to increase its production indefinitely. Yet, somehow, each new year sees a new record output set. In the first two months of 1932, South African production totaled 1,850,000 oz. At that rate, this year's output will be 11,100,000 oz., or about 225,000 oz. higher than in 1931. There is every reason for believing that the rate will be maintained. Labor supply is plentiful. Many mines have been able to increase development work during the last two years so that they are now in a position to handle increased tonnages of ore.

It is true that some of the Rand mines are perilously close to the end of their careers. The Meyer & Charlton will probably close down this year. Other mines have lives that are definitely limited to three or four years. To counteract this shrinkage, there are the two new Far East Rand producers—Daggafontein and East Geduld, neither of which has yet reached full-scale operations. At peak, they will jointly produce about 500,000 oz. annually. Development on the great Randfontein mine—the largest in the district from the standpoint of acreage held—has been favorable, and there is a definite prospect that Randfontein may yet surpass Crown Mines and Government Gold Mining Areas as the leading Rand producer. That might mean an increase in the output of this single mine of as much at 400,000 oz. annually.

## World Gold Production in 1930 and 1931

All figures in fine ounces

| Country | 1930 | 1931 |
|---|---|---|
| Union of South Africa | 10,719,760 | 10,874,145 |
| Canada | 2,102,068 | 2,679,728 |
| United States (*b*) | 2,100,395 | 2,191,881 |
| Russia | 932,350 | 1,000,000 (*a*) |
| Mexico | 668,977 | 650,000 (*a*) |
| Australia | 466,435 | 591,742 |
| Southern Rhodesia | 547,630 | 532,111 |
| Japan (*c*) | 388,085 | 425,000 (*a*) |
| India | 328,242 | 329,673 |
| British West Africa | 248,491 | 260,000 (*a*) |
| Belgian Congo | 194,154 | 240,000 |
| Philippine Islands | 185,208 | 174,000 |
| New Zealand | 120,542 | 135,097 |
| Brazil | 123,161 | 115,473 |
| Sweden | 60,000 | 90,000 |
| Others | 964,512 | 1,011,150 |
| Total | 20,150,000 | 21,300,000 |

(*a*) Estimated. (*b*) Does not include Philippine Islands. (*c*) Does not include Chosen (Korea).

The question that has been most agitating Rand producers in recent months is: Will South Africa remain on the gold standard? South Africa is the only British dominion that is still on the gold standard. That means that the South African pound is worth $4.86 while the English pound is fluctuating around $3.70. Trade between South Africa and other British dominions is severely restricted and South African commodity producers find themselves at a distinct disadvantage because their costs are higher than those in competing dominions. The Messina copper mine, for instance, does not have the advantage that the Roan Antelope mine, in Northern Rhodesia, enjoys.

Not only would the South African farmers and producers of base metals and non-metallics benefit by abandonment of the gold standard and linking to the English pound, it is maintained, but the great Rand mines themselves would be materially aided. In the first place, reliable estimates have been made that a reduction of 2s. per ton in Rand costs will increase the life of the Rand 30 per cent, and a reduction of 4s. per ton may double the life of the district. Huge tonnages of low-grade material in mines now being worked would be converted into ore. And abandonment of the gold standard would immediately effect such a reduction. The second argument in favor of abandonment of the gold standard as it affects the Rand mines is that, under present conditions, capital cannot be obtained for the development of new ore-bearing areas. English investors would rather put their pounds into West Africa or

# The World's Leading Gold Mines

**Arranged in order of output**

| Name | Location | 1931 Production Gold, Oz. | 1931 Production Ore, Tons | 1930 Production Gold, Oz. | 1930 Production Ore, Tons | Dividends 1931 | Dividends 1930 |
|---|---|---|---|---|---|---|---|
| Government Gold (*a*) | Union of S. A. | 1,129,872 | 2,435,000 | 1,007,095 | 2,438,000 | £1,260,000 | £1,260,000 |
| Crown Mines (*a*) | Union of S. A. | 986,329 | 3,136,000 | 924,298 | 2,905,000 | £660,144 | £636,567 |
| New Modderfontein (*a*) | Union of S. A. | 805,560 | 1,965,000 | 862,506 | 1,879,000 | £1,610,000 | £1,855,000 |
| Randfontein (*a*) | Union of S. A. | 745,313 | 2,751,000 | 652,606 | 2,573,000 | £101,589 | None |
| Lake Shore (*b*) | Canada | 533,757 | 816,580 | 378,690 | 550,501 | $4,800,000 | $3,000,000 |
| East Rand Pty. (*a*) | Union of S. A. | 501,085 | 1,865,200 | 491,095 | 1,951,325 | £75,000 | None |
| Hollinger (*b*) | Canada | 487,123 | 1,640,705 | 494,531 | 1,625,868 | $3,444,000 | $3,444,000 |
| New State Areas (*a*) | Union of S. A. | 479,205 | 958,000 | 445,938 | 930,000 | £976,621 | £891,348 |
| Homestake Mining (*c*) | United States | 432,381 | 1,403,939 | 406,000 | 1,364,456 | $2,122,302 | $2,009,280 |
| Brakpan Mines (*a*) | Union of S. A. | 414,539 | 1,138,500 | 391,852 | 1,040,200 | £408,000 | £446,250 |
| Springs (*a*) | Union of S. A. | 413,688 | 843,000 | 408,250 | 836,700 | £581,250 | £562,500 |
| Sub Nigel (*a*) | Union of S. A. | 352,624 | 410,700 | 304,915 | 357,200 | £487,500 | £375,000 |
| Robinson Deep (*a*) | Union of S. A. | 334,457 | 1,158,000 | 365,781 | 1,339,000 | £155,052 | £132,180 |
| Geduld Proprietary (*a*) | Union of S. A. | 323,616 | 1,012,000 | 322,884 | 1,011,000 | £493,039 | £474,778 |
| Langlaagte Estates (*a*) | Union of S. A. | 317,659 | 943,000 | 326,412 | 961,500 | £303,966 | £303,966 |
| Teck-Hughes (*b*) | Canada | 294,422 | 444,410 | 260,774 | 338,555 | $3,118,144 | $2,872,286 |
| West Rand Consolidated | Union of S. A. | 287,225 | 1,066,000 | 290,671 | 1,087,000 | None | None |
| Consolidated Main Reef (*a*) | Union of S. A. | 271,140 | 795,000 | 258,856 | 733,900 | £151,542 | £121,234 |
| Van Ryn Deep (*a*) | Union of S. A. | 268,940 | 753,000 | 297,602 | 771,000 | £299,223 | £359,068 |
| Modder Deep (*a*) | Union of S. A. | 268,790 | 533,800 | 275,251 | 530,400 | £600,000 | £650,000 |
| Modder B (*a*) | Union of S. A. | 264,895 | 887,000 | 293,517 | 840,000 | £420,000 | £560,000 |
| City Deep (*a*) | Union of S. A. | 264,018 | 1,021,000 | 306,425 | 1,157,500 | None | None |
| Simmer & Jack (*a*) | Union of S. A. | 262,548 | 926,800 | 250,485 | 916,700 | £41,667 | £31,250 |
| Modder East (*a*) | Union of S. A. | 255,908 | 865,500 | 242,149 | 833,000 | £186,161 | £186,161 |
| Noranda Mines (*cn*) | Canada | 253,363 | 1,012,005 | 117,258 | 733,971 | $1,119,886 | $5,599,430 |
| Nourse Mines (*a*) | Union of S. A. | 248,329 | 827,600 | 223,198 | 760,700 | £58,774 | £48,979 |
| McIntyre-Porcupine (*c*) | Canada | 229,413 | 617,425 | 225,786 | 565,510 | $798,000 | $798,000 |
| West Springs (*a*) | Union of S. A. | 210,498 | 851,800 | 218,054 | 815,800 | £134,475 | £179,300 |
| Geldenhuis (*a*) | Union of S. A. | 198,843 | 861,900 | 186,236 | 811,900 | £56,666 | £49,583 |
| Durban Roodepoort (*a*) | Union of S. A. | 183,020 | 565,200 | 172,562 | 520,000 | £56,250 | £28,125 |
| Alaska Juneau (*c*) | United States | 178,532 | 4,162,350 | 163,312 | 3,924,460 | $584,950 | None |
| Ashanti Goldfields (*d*) | Gold Coast | 172,683 | 147,104 | 151,666 | 129,379 | £337,500 | £250,000 |
| Kilo-Moto Gold (*e*) | Belgian Congo | 170,003 | (*f*) | 147,799 | (*f*) | 19,431,267 fr. | (*e*) |
| Dome Mines (*c*) | Canada | 169,686 | 542,600 | 37,416 | 67,600 | $953,334 | $953,334 |
| Rose Deep (*a*) | Union of S. A. | 153,028 | 741,500 | 155,841 | 733,400 | £16,577 | £33,150 |
| Witwatersrand Gold (*a*) | Union of S. A. | 146,423 | 717,500 | 145,355 | 659,500 | £23,481 | £46,962 |
| Lake View & Star | Australia | 143,493 | 231,873 | 132,578 | 157,693 | None | None |
| Wright-Hargreaves (*c*) | Canada | 140,520 | 266,352 | 117,455 | 220,432 | $825,000 | None |
| New Kleinfontein | Union of S. A. | 124,782 | 611,200 | 135,192 | 619,200 | None | None |
| Cam & Motor (*d*) | Rhodesia | 123,339 | 293,000 | 128,656 | 285,000 | £150,000 | £132,500 |
| Van Ryn Estate (*a*) | Union of S. A. | 122,488 | 530,500 | 119,024 | 496,000 | £31,250 | £25,000 |
| St. John del Rey (*d*) | Brazil | 115,473 | 221,800 | 123,161 | 226,800 | £67,598 | £81,186 |
| Witwatersrand Deep | Union of S. A. | 103,767 | 442,900 | 113,906 | 498,000 | None | None |
| Mysore Gold (*d*) | India | 96,042 | 182,731 | 101,904 | 190,829 | £43,005 | £76,250 |
| Empire Star (*c*) | United States | 96,000 (*g*) | 214,734 | 79,800 | 177,503 | $95,000 | None |
| Luipaards Vlei | Union of S. A. | 94,471 | 374,500 | 85,634 | 337,500 | None | None |
| Phelps Dodge (*cq*) | United States | 90,720 | (*l*) | 63,392 | (*l*) | $4,210,892 | $7,685,314 |
| Premier Gold (*ch*) | Canada | 82,394 | 242,317 | 90,084 | 256,836 | $635,713 | $1,050,773 |
| Benguet Consolidated (*c*) | Philippines | 80,608 | 112,524 | 85,799 | 114,786 | $850,000 | $1,200,000 |
| Nundydroog (*d*) | India | 79,836 | 123,039 | 78,746 | 127,144 | £63,675 | £70,750 |
| Boliden | Sweden | 78,200 | 90,057 | 56,900 | 69,797 | None | None |
| Waihi Gold (*dh*) | New Zealand | 75,468 | 223,722 | 78,680 | 220,984 | £95,181 | £95,181 |
| Great Boulder Pty. (*d*) | Australia | 73,904 | 120,140 | 65,420 | 91,429 | £21,875 | £21,875 |
| Natomas Dredging | United States | 70,000 (*g*) | (*l*) | 66,251 | 14,901,143 (*i*) | | |
| Balatoc Mining (*c*) | Philippines | 68,085 | 57,675 | 61,001 | 52,577 | $675,000 | $400,000 |
| Globe & Phoenix (*d*) | Rhodesia | 65,865 | 72,512 | 65,961 | 72,297 | £80,000 | £80,000 |
| Champion Reef (*d*) | India | 65,719 | 98,930 | 62,661 | 91,545 | £26,000 | £32,500 |
| Ooregum (*d*) | India | 63,023 | 135,095 | 63,700 | 143,761 | £6,000 | £53,000 |
| Transvaal Gold (*a*) | Union of S. A. | 60,295 | 190,216 | 58,544 | 178,004 | £21,449 | £14,299 |
| Wiluna Gold | Australia | 58,898 | 215,833 | None | None | None | None |
| East Geduld | Union of S. A. | 56,003 | 231,700 | None | None | None | None |
| Oriental Consolidated (*c*) | Chosen | 54,987 | (*l*) | 50,204 | 208,366 | $429,390 | $214,695 |
| Meyer & Charlton | Union of S. A. | 49,080 | 206,120 | 53,086 | 213,400 | None | None |
| Eureka Standard (*c*) | United States | 48,207 | 36,622 | 30,541 | 28,457 | $179,951 | $89,975 |
| Yuba Consolidated (*j*) | United States | 47,006 | 14,446,498 (*i*) | 60,212 | 17,222,691 (*i*) | (*l*) | (*l*) |
| Boulder Perseverance | Australia | 45,500 | 84,270 | 42,101 | 79,319 | None | None |
| South Kalgurli (*d*) | Australia | 44,900 | 101,171 | 34,281 | 59,134 | £31,125 | £31,125 |
| Sylvanite Gold (*c*) | Canada | 43,437 | 91,621 | 38,303 | 81,213 | $131,980 | $65,590 |
| Taquah & Abosso (*d*) | Gold Coast | 42,922 | 120,053 | 44,946 | 118,589 | £24,125 | £24,125 |
| Wanderer Consolidated | Rhodesia | 42,248 | (*l*) | 44,580 | (*l*) | None | None |
| Sons of Gwalia | Australia | 41,900 | 150,564 (*o*) | 38,197 | 155,894 (*o*) | None | None |
| Howey Gold | Canada | 41,702 | 211,552 | 22,147 | 110,438 | None | None |
| Chosen Corporation (*k*) | Chosen | 39,349 | 115,100 | 32,900 | 112,500 | None | None |
| Cresson Consolidated (*c*) | United States | 38,385 | 80,479 | 32,337 | 79,347 | $48,800 | $97,600 |
| Lonely Reef (*d*) | Rhodesia | 38,264 | 255,675 (*o*) | 45,937 | 255,800 (*o*) | £57,859 | £57,859 |
| Frontino Gold (*dk*) | Colombia | 37,130 | 36,140 | 18,492 | 24,380 | £7,688 | £2,939 |

| Name | Location | 1931 Production Gold, Oz. | Ore, Tons | 1930 Production Gold, Oz. | Ore, Tons | Dividends 1931 | 1930 |
|---|---|---|---|---|---|---|---|
| Grand Lacs Africains (*e*) | Belgian Congo | 36,940 | (*l*) | 31,282 | (*l*) | 1,400,000 fr. | (*e*) |
| Coniaurum | Canada | 36,278 | 130,585 | 35,664 | 122,972 | None | None |
| Siscoe Gold | Canada | 35,936 | 55,675 | 17,768 | 33,744 | (*m*) | None |
| Idaho-Maryland | United States | 33,400 (*g*) | 54,000 (*g*) | 12,146 | 19,452 | None | None |
| Rezende Mines (*d*) | Rhodesia | 32,557 | 76,400 | 32,300 | 76,400 | £37,500 | £32,813 |
| Shenandoah-Dives | United States | 30,561 | 170,795 | 17,753 | 100,141 | None | None |
| Pioneer Gold (*b*) | Canada | 30,000 | 34,000 | 16,930 | 30,000 | $155,840 | None |
| Kirkland Lake Gold | Canada | 28,315 | 52,628 | 25,764 | 52,106 | None | None |
| Elkoro Mines | United States | 28,000 (*g*) | (*l*) | 25,959 | 57,539 | None | None |
| Sherwood Star (*d*) | Rhodesia | 27,450 | 55,200 | 35,746 | (*l*) | £30,000 | £30,000 |
| Balaghat Gold | India | 25,835 | 41,850 | 22,256 | 39,200 | None | None |

(*a*) Pays dividends in South African pounds, which are still at par of $4.86, U. S. currency.
(*b*) Pays dividends in Canadian dollars, which, since last September, have fluctuated between 85c. and 90c., U. S. currency.
(*c*) Pays dividends in U. S. currency.
(*d*) Pays dividends in English pounds, which, since last September, have fluctuated between $3.40 and $3.90.
(*e*) Pays dividends in Belgian francs, worth 2.78c., U. S. currency. Dividend paid in 1931 was out of profits for 1930. Previous year not available.
(*f*) Handles both alluvial and lode material, so no tonnage figure can be given.
(*g*) Official data unobtainable. Estimated.
(*h*) Also an important silver producer, but gold is most valuable produet.
(*i*) Cubic yards of gravel dredged.
(*j*) Years ended Feb. 28, 1931, and Feb. 28, 1930.
(*k*) Years ended June 30, 1931, and June 30, 1930.
(*l*) Not available.
(*m*) Initial dividend of 4c. a share on 4,000,000 shares paid in March, 1932, out of 1931 profits.
(*n*) Also an important copper producer, but gold was most valuable product in 1931.
(*o*) Ore and tailing treated.
(*q*) Primarily a copper producer; figures include Calumet & Arizona statistics.

Australia, where the currency has also depreciated, than they would into South Africa, where an investment of one English pound is equivalent to only about fifteen South African shillings. There are areas now being drilled to the south of the Far East Rand and on the western extension of the West Rand that some day will probably be put into production. Abandonment of the gold standard would undoubtedly hasten that day.

On the other side of the ledger, the argument can be advanced that any cost reduction obtained through abandonment of gold would be temporary. Eventually, labor and materials and other costs would rise, in terms of the depreciated currency, and the advantage would disappear. Some time would have to elapse before the low-grade areas could be put into condition to produce. By that time, costs might conceivably have risen again. Furthermore, South Africa, as the world's leading gold producer, has much to gain by continuing to advocate gold as the metallic basis for currency issues. Were many countries to abandon gold and the possibilities of "managed" currencies thoroughly investigated and adopted, gold might be thrown into the discard. In any event, the fact remains that the advantage to be obtained by the South African gold mines from depreciation in currency would be purely temporary. Mining of low-grade tonnages on the Rand will have to be effected through permanent cost reductions.

The largest increase in gold production by any country in 1931 was made by Canada, where output rose 557,000 oz. Canada is now firmly entrenched as the second largest gold producer among the nations. Its percentage of the world total in 1931 was 12.5. compared with 10.3 per cent of the 1930 total. Further increases are expected from Canada, although 1932 is not likely to see quite the same growth as 1931. None of the large mines in Kirkland Lake or Porcupine is at present adding to its facilities, so that the output from these two camps is likely to be at about the same rate as in the closing months of 1931. Several new mines will start production in 1932, the most important of which will be the O'Brien, Ashley, Moss, San Antonio, Lorne, and Bussiere. None of these will be a large producer, but their aggregate output may be as high as 100,000 oz.

In Quebec, the new Beattie mill will be constructed, but it is too early yet to know whether it will enter production this year. The first unit will have a 1,000-ton capacity, and, on the basis of $3 per ton recovery, annual output should be over 50,000 oz. Siscoe is one Quebec producer that will add substantially to its 1931 output. Discovery of important additional reserves of gold-bearing copper ore at the Noranda mine insures a continued substantial gold production from this property, now adding more than 250,000 oz. annually to the world's supply.

In British Columbia the Pioneer mine is making provision for tripling its mill capacity. If grade can be maintained at the increased tonnage, Pioneer will be comparable with the Ashanti mine, in West Africa, and the Balatoc, in the Philippine Islands. Its production would be about 120,000 oz. annually, an increase of about 80,000 oz. Discoveries of high-grade gold ore at Hecla's Union mine may temporarily swell output from that property. The company does not expect a large tonnage, however. The Premier mine, which has long been British Columbia's leading gold producer, is steadily exhausting its ore reserves. British Columbia gold output will increase in 1932, but unless new deposits are found, further increases appear unlikely. Renewed activity in alluvials may help.

Summing up the prospects for Canadian gold production this year, an output of about 3,000,000 oz. appears likely. This would be an increase of 320,000 oz.

The United States has long been considered a declining factor in gold production. Nevertheless, it still contributes 10 per cent of the annual output, and the last two years have shown increases. The 1931 output was the highest since 1925. Base-metal mines, which produced more than 500,000 oz. of gold in 1929, produced only about 250,000 oz. in 1931. In other words, gold mines have actually increased production 250,000 oz. more.

Alaska, California, and South Dakota are the leading gold producers. In Alaska, the dredging activities of Fairbanks Exploration, which holds extensive ground near Fairbanks, and the increased output of Alaska Juneau have been responsible for recent improvement. Discovery of ore of better than average grade in the North orebody of Alaska Juneau indicates a further increase there this year. Several small but rich gold mines in camps such as Willow Creek, Ferry, and Nabesna will yield more gold in 1932.

In California, the interest in gold mining has resulted in reopening of hundreds of old properties along the Mother Lode. Old stamp mills are being reconditioned, and, although profits may not be made in every mining operation, a substantial aggregate output is indicated. Empire-Star Mines is increasing its holdings in the Grass Valley district and is building a 500-ton mill at the Murchie mine that will be an important producer. Idaho-Maryland made a high-grade strike last year and more than doubled its production, with further increases anticipated.

The improvement in grade at the famous Homestake mine has been responsible for the increase in South Dakota's output. Interest in the Lead district has been stimulated by the increasing dividend returns from this remarkable mine, and several exploration campaigns are under way. So far as is known, no new producers have yet started up, however.

Idaho, which has not been an important gold producer for years, will be able to boast at least two new mines

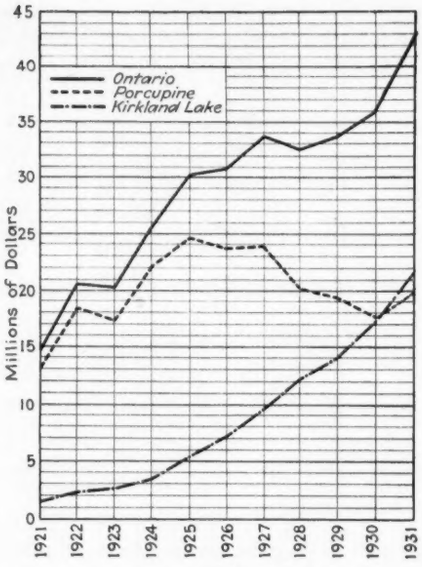
this year—the Atlanta, controlled by St. Joseph Lead, and the Yellow Pine, owned by F. W. Bradley. If sufficient power can be obtained, the latter will become a really large producer, present plans contemplating expansion to 1,500 tons of ore daily. Grade will be more than $5 a ton.

In Utah, the Eureka Standard mine averaged 1.3 oz. of gold to the ton of ore shipped in 1931. This makes Eureka Standard the highest-grade large gold mine in the world, on the basis of available records. A careful estimate of the United States as a whole would indicate a fair increase in 1932, perhaps even as much as 200,000 oz.

Australia's production increased 25 per cent in 1931. Most of the increase was due to starting of operations at the Wiluna mine, expansion at Lake View & Star, and the recovery of gold from old alluvial districts by unemployed workers. Construction of a 150-ton mill at the Mount Coolon mine, in Queensland, where ore averages better than 1 oz. per ton, means an annual production from that property of 50,000 oz. Completion of the new flotation plant at Lake View & Star, coupled with steady production from Wiluna and increased returns from some other Kalgoorlie mines, indicates that Western Australia alone ought to produce close to 600,000 oz. annually. If reopening of Bendigo mines and the other activities going on at different camps in eastern Australia bring any results at all, Australian gold production will easily reach 700,000 oz. annually. As Australian currency has depreciated even more than the English pound, Australian gold mines are obtaining more than 140s. per ounce in Australian currency. This means substantial reductions in operating costs, on a gold basis. The gold bounty proposed by the federal government may be removed because of its own financial difficulties and the big premium that the mines are obtaining through exchange.

No data are obtainable from authentic sources concerning Russian gold production in 1931. In 1930, the gold mines produced 932,350 oz., according to statements from official sources (unofficial estimates as high as 1,300,000 oz. have been used by various statistical organizations). The 1931 output was probably higher than that of 1930. According to a statement by P. A. Serebrovsky, official of the non-ferrous metal trust, gold production in 1932 will be increased 125 per cent over the 1931 record. That would mean an increase of more than 1,000,000 oz. This is so large that, for the purposes of this study, I have omitted Russia from consideration and assumed that output will be the same as in 1931.

Discovery of the El Tambor placer field and of the new gold-silver vein in the Kildun property, Matehuala, has helped to maintain Mexican gold output. Base-metal and silver production,




**In ten years Ontario's gold output has grown phenomenally, thanks to Kirkland Lake, as this chart shows**

the chief source of Mexican gold output, have been curtailed. Output in 1932 is likely to be lower than in 1931 unless some new discoveries are made.

Southern Rhodesia's gold output has been declining in recent years with the exhaustion of some of the older mines and the decline in grade at Cam & Motor. The depreciation in Rhodesian currency, which is linked to sterling, has stimulated interest in small properties. Recent months show slight improvement over early 1931 returns, and a small increase in 1932 seem probable. The Wanderer mine, of which much was expected, has achieved low costs, but its ore position is not wholly satisfactory and the expansion program has been postponed.

West Africa is steadily regaining importance as a gold-producing center. Extensive exploration is being undertaken by Consolidated Gold Fields interests. In addition, the Ariston and Taquah & Abosso properties have steadily improved their positions by cutting costs and increasing tonnages. The Ashanti Goldfields, the chief producer, is one of the most profitable gold mines in the world, and is making an enviable record in dividend payments. Production is now stabilized at about 170,000 oz. annually. Its subsidiary, the Bibiani mine, is putting up a 100-ton mill and may add 20,000 oz. or so to the production.

Belgian Congo officials look for an output of 10,000 kg., or 321,500 oz., in 1933. In 1931, records for the seven leading companies indicate, output was about 240,000 oz. Apparently 1932 should see a recovery of about 275,000 oz. Kilo-Moto Gold continues to increase production. It is supplanting its hydraulic units with new dredges and increased milling facilities for the lode deposits. Most of the Congo's output is recovered from alluvial deposits, and recent work in the eastern section indicates that favorable ground is still to be opened up.

The Boliden deposits, in Sweden, appear destined to be among the largest gold producers in the world. The ore has a fair copper content, so perhaps Boliden should properly be considered in the same class as Noranda. Boliden ore, however, averages better than 0.5 oz. of gold per ton, compared with about 0.2 oz. of gold in Noranda ore. Production in 1931 was about 80,000 oz. Expansion of production facilities will increase this to 380,000 oz. annually. For 1932, I have estimated production at 9,000 kg., or about 280,000 oz., on the assumption that the full capacity of the enlarged smelter will be available, as scheduled, in June.

New Guinea is a prospective gold producer about which much has been heard recently. Crude hand operation of the placer deposits has been yielding about 40,000 to 50,000 oz. of gold annually for several years. The first dredge of the Bulolo Dredging enterprise has just been placed in operation. Its capacity is 150,000 cu.yd. per month, and on the basis of a gold content of 50c. per cubic yard, output should be about 40,000 oz. annually. Two other dredges, of similar capacity, will be installed, at least one of them starting work this year. In addition, New Guinea Goldfields is assembling equipment for a 100-ton pilot mill that will handle ore averaging better than 1 oz. per ton. Production is expected to start in May. New Guinea's production in 1932 will probably be about 100,000 oz. and steady expansion may be expected for several years in the future.

The decline in Philippine gold production indicated by official statistics for 1931 is surprising. Operations in the Benguet district have been steadily expanding. Recent developments in the Benguet Consolidated property have opened new high-grade ore which has considerably increased reserves. Balatoc is doubling the capacity of its milling plant again and should produce in 1932 nearly as much as the entire dependency did in 1931. Some important mining interests are exploring properties in the district and a high-grade strike was reported at the Big Wedge group. Itogon Mining, one of the smaller mines, has doubled its mill capacity also. Philippine production in 1932 will probably be about 250,000 oz.

On the basis of the estimates made in this study, 1932 gold production will show an increase of more than 1,200,000 oz. over the figures for 1931. This does not include any increase in Russia or in the countries other than those specifically cited. Actual performance may well result in an even greater increase and one that will make 1932 the best year gold mining has ever experienced.

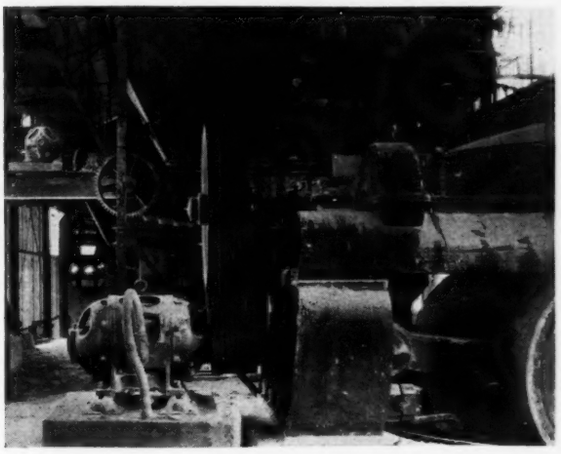
# Mining and Processing Fireclay

**George J. Young**
*Associate Editor*

WHEN plant improvement becomes necessary, commercial and cost considerations frequently result in a new plant and a new location. Such was the case of the Stockton Fire Brick Company, of San Francisco, which derived its raw material from deposits near Ione and Lincoln, and operated a firebrick plant at Stockton, Calif. The new firebrick plant was placed at Pittsburg, an industrial center, one of the principal markets for the company's products. A steel mill, oil refineries, a smelter, and other plants are in the near-by area, which has advantages in rail and water transportation. The company's clay pit at Lincoln involves railroad transportation of 100 miles, and the clay mine at Ione a haul of 75 miles, to Pittsburg. The Stockton plant is 72 and 47 miles from the respective clay deposits mentioned. Thus, the new plant, although in the heart of an industrial district, also involved a greater rail distance from the source of raw materials. However, the new location offered the important advantage of a supply of natural gas for kiln purposes. Improvements in firebrick technology made the new plant necessary, although the old plant at Stockton is being continued in operation on a restricted basis.

The fireclay bed near Ione, at the base of the Tertiary, is worked by underground methods. It is known as the Jones Butte clay mine, or the Edwin mine. The clay bed, lenticular, varies from 8 to 10 ft. thick, and is characterized by irregularities of the hard, lateritic Tertiary basement. The equipment consists of mine track, 16 cu.ft. end-dump cars, a receiving bin, picks, bars, and scoop shovels. The original mine is opened by an adit, and the clay is mined by small rooms opened up on each side of the supplementary drifts,

**Power shovel and car equipment. Overburden bench in background**

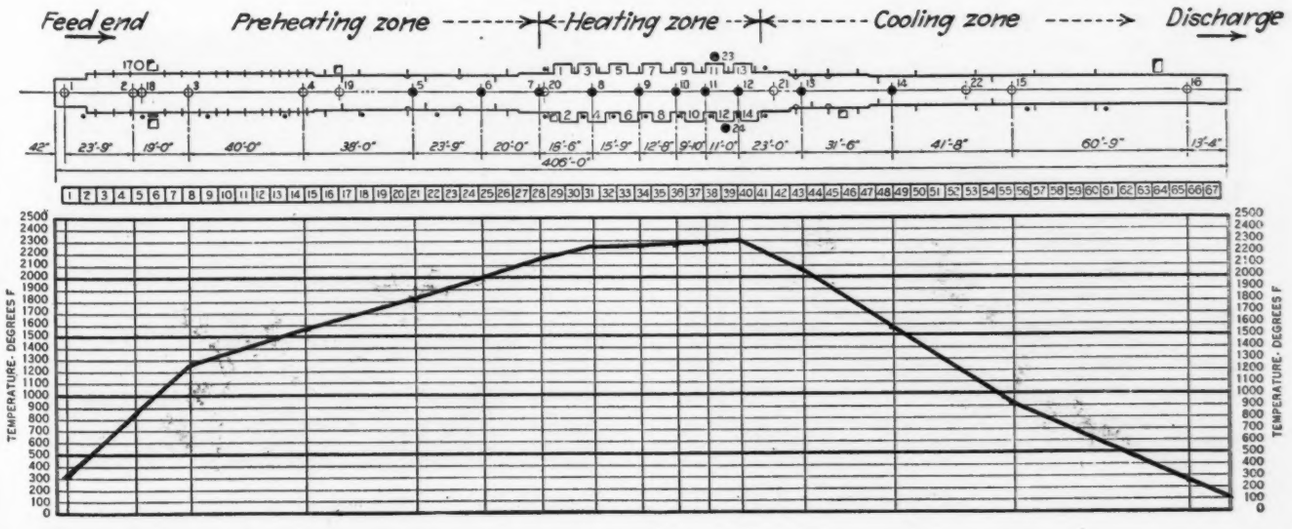


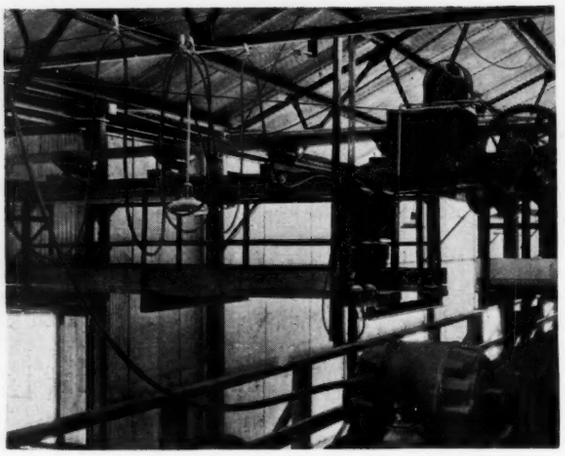
**Dry pan showing V-belt drive; feed hopper and screens in background**

**HARROP CERAMIC SERVICE CO.**
**HARROP CAR TUNNEL KILN**

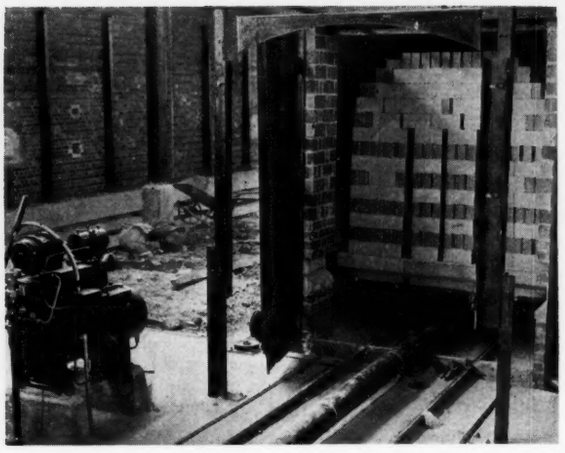
**TEMPERATURE RECORD**
**STOCKTON FIRE BRICK CO.**
**PITTSBURG, CALIFORNIA**

**Temperature chart of tunnel kiln**





**Shuttle conveyor rig showing electrical cable rig and conveyor drive**



**Hydraulic drive on tunnel kiln. Car starting on its trip through the kiln**

and separated by pillars. Props, spaced systematically, give support for the roof until the working is completed, when it is caved. Working begins at the further limit of each drift and retreats toward its entrance. Narrow, untimbered drifts are driven. Explosives are used, and undercutting is also practiced.

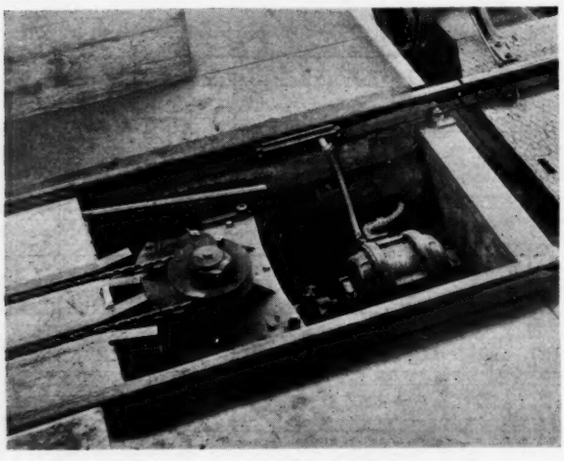
Mined clay, loaded from the bin into auto trucks, is hauled 1.5 miles to the Edwin siding of the railroad, where it is dumped into gondolas. A detailed account of the deposit and methods, by C. N. Schuette, is given in the *Engineering and Mining Journal,* Feb. 2, 1929, p. 196. When I visited the mine recently, the final stage of finishing this part of the underground operations was in progress. A new mine has been opened out from a new entrance. However, in this working, a short incline with hoisting equipment is necessary to bring the cars to the surface. Development and mining in the new area will be similar to practice already established.

The clay pit, a short distance north of Lincoln, has been operated for six seasons. As the deposit is of considerable size, and as the clays are of good quality, much attention was given to the layout and equipment for systematic and low-cost operation. The present length of the pit is 1,600 ft.; its vertical range, 70 ft. Overburden, averaging 35 ft. thick, reaches a maximum of 38 ft. It is removed in two benches and is kept about 50 ft. ahead of the clay. The ratio of overburden to clay is about 2½ to 1. This large proportion of waste rock to clay makes its disposal an important problem. Waste-rock dumps have been established near by. Waste rock is andesitic breccia, relatively soft and easily drilled by Sullivan auger drills. Holes are 18 ft. deep. Included within the breccia are harder masses of various sizes. When these are encountered in drilling, the hole is abandoned and a new hole started. The smaller imbedded pieces, after blasting, are broken to shovel size by paving breakers, and the large masses are blockholed and blasted. Large pieces cast aside by the shovel are blasted before beginning the next cut.

Entrance to the pit is at the northwest corner, and the pit is developed parallel with the northwest-southeast axis of the low hill. The approach is on a 2 per cent grade. The fireclay, about 15 ft. thick, is underlain by a reddish clay, which is also mined. Pit drainage is provided by a sump and a 5-in. Gould centrifugal pump. Track gage in the pit is 36 in., with limiting grade of 2 per cent. A Y with a 150-ft. radius is provided for turning trains.

Pit equipment consists of a 1¼-cu.yd. P&H, full revolving gasoline shovel, mounted on Caterpillar tractors; an 8-ton Plymouth gasoline locomotive, and two trains each of five 3½-cu.yd. rocker-type cars. With this equipment the maximum day's output is 200 cars; minimum 150 cars; average, 180 cars. The pit crew consists of a foreman, a shovel operator, a locomotive operator, two dump men, an oiler, a driller, and sometimes an extra man for blockholing. The total number employed, twelve, handle 300 tons per shift. In the six seasons of operation, 550,000 tons of clay and waste rock has been moved. In excavating the clay a selection is made, and this is facilitated by sampling each 5-ft. cut (15 ft. high) at 20-ft. intervals.

Sufficient storage of clay is provided to avoid pit operation during the rainy season. The preparation of the clay is simple. Run-of-pit clay can be delivered to standard gondolas on a spur track or to a single-roll Stevenson crusher, where it is reduced to 3 in. and discharged on an 18-in. conveyor belt,

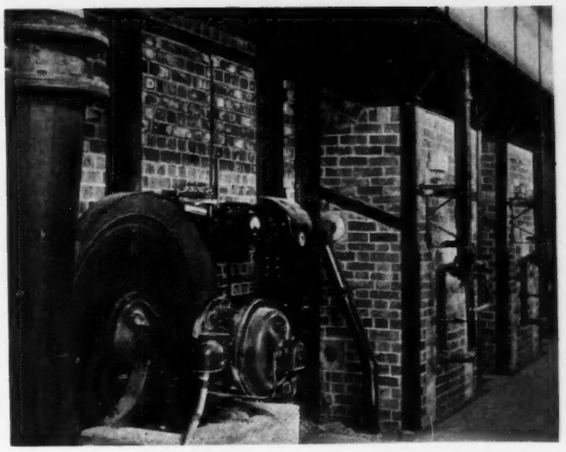


**Chain drive on No. 1 tunnel dryer**

**Hum-mer screen floor**

which delivers to an automatic tripper, which in turn spreads the clay on the pile in the 70x300-ft. storage house. The clay is air-dried while in storage. During the summer this is easily accomplished.

Reclamation from the storage pile is accomplished by a tunnel and horizontal conveyor, chutes, controlled by arc gates, discharging on the conveyor. A cross conveyor elevates the material to three 50-ton bins. The end bin of the series discharges through chutes in the side of the building into railroad cars. All three receiving bins are equipped with apron-plate feeders (2-hp. motor), which deliver to a chute and thence to a 5-O Raymond low-side mill, operated by a 60-hp. motor. A fan, operated by a 40-hp. motor, delivers the fine product to a cyclone with which it is in closed circuit. A screw conveyor on top of the finish bins distributes the pulverized clay to the bins, from which it is spouted to a Bates sacking machine and delivered to storage in 100-lb. paper bags. Bulk shipments can also be made from the finish bins. One of the receiving bins is also served by a 24-in. hammer mill, made by the Pulverizing Machinery Company, operated by a 30-hp. motor and delivering a screened product ($\frac{1}{8}$ in. finest screen) to an elevator, which delivers to one of the finish bins. The coarse clay product is sacked in burlap. The plant is thus equipped to deliver three products—air-sorted fine clay, granular clay, and 3-in. lump clay. Two men operate the pulverizing plant. The layout is simple and direct.

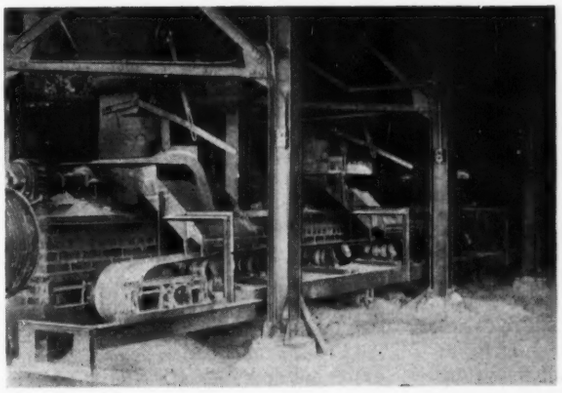


**Tunnel kiln, natural-gas burners, and centrifugal compressor**

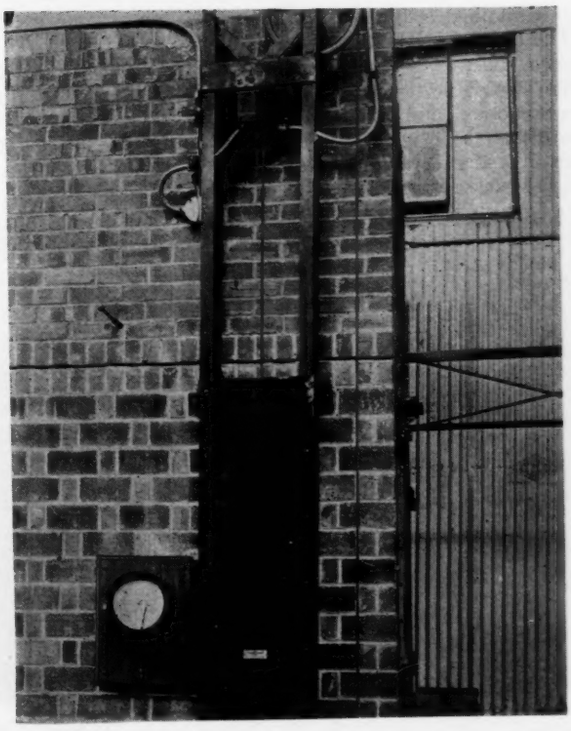
The firebrick plant at Pittsburg, recently constructed, is noteworthy in that it represents a careful selection of modern equipment and an advanced technology in brick making. The Lincoln clay and the Ione clay have different characteristics, the latter being much less plastic than the former, and bordering upon a flint clay. Both are excellent fireclays, and are mixed with two-thirds grog, made at the plant. Two types of brick are produced, one by the stiff-mud process and the other by the dry press. In addition, specialized products are made by hand molding.

Clays from the Ione and Lincoln deposits, delivered in gondolas, are discharged into a steel bin beneath the railroad tracks. Double opposed Link-Belt feeders and a 20-in. conveyor belt deliver the various clays to primary bin storage. These bins are "stalls," open on one side. A 10x20-in. Allis-Chalmers jaw crusher also discharges upon the conveyor belt and is used for crushing grog, which is delivered to the primary bin storage. A cross conveyor distributes the different components of the mix to separate stalls.

The mixes are made up by shoveling from the bins into wheelbarrows which are discharged into a hopper serving a 20-in. conveyor that delivers the coarse mix into a hopper served by a Link-Belt apron feeder discharging into a 10-ft. dry pan (Maximuller) driven by a Texrope drive and 60-hp. motor. The pan discharge (through slots in the peripheral area of the bottom plate) goes to a system of conveyors that deliver the undersize to a battery of four 4x6-ft. Hum-mer screens receiving the ground clay from a specially designed Nickerson feeder through a diagonal slot over each screen, a double chain with steel flights distributing the material in the feeder. Oversize from the screens is returned to the dry pan by a conveyor and spout. Undersize is delivered by conveyors to eight steel bins (each of 50 tons' capacity—round tanks with conical bottoms). Four of the bins serve the stiff-mud machine and four the dry presses. A spout discharge delivers the stiff-mud mix to a conveyor that discharges into a trough-type pugging machine, where sufficient water is added and the wet



**Above — disk feeders delivering dry mix to conveyor belt**



**At right, recording temperature and damper control on dryer**

mixture delivered to the brick machine.

The stiff-mud machine is of the auger double-run type, 4¼x4¼ in. section with wire cutter. This machine is used in the preparation of grog brick and runner brick for use in steel ingot casting by the bottom-pour method, in vogue at Pacific Coast steel plants. Grog brick are sent to the dryers, but runner brick are re-pressed in a press of the company's own design. Compressed air is supplied for this press by an I.R. Imperial-type compressor. Stiff-mud bricks are stacked upon cars and sent to No. 1 tunnel dryer heated by waste heat from the tunnel kiln. The dryer is under controlled temperature and is maintained at 160 deg. F. After drying, the stiff-mud bricks are stacked upon dry-press bricks on the tunnel kiln cars, which are routed through a second tunnel dryer before they are delivered to the tunnel kiln.

Storage bins for the dry press mix are equipped with Link-Belt disk feeders delivering to a system of conveyors which discharge into bins feeding into two Boyd dry presses. En route, the dry-mix receives sufficient water to bring its moisture content to 8 per cent, mixing being accomplished in a barrel-type mixer. All standard-shape firebrick and tile are made upon the dry presses and stacked directly upon tunnel-kiln cars as they are taken from the press. They are sent to No. 2 dryer after receiving a top load of brick from No. 1 dryer cars.

No. 2 dryer (150 ft. in length) takes 25 kiln cars, which are pushed through the dryer by a hydraulic ram. Under present conditions each 6-ft. car takes 2½ days to pass through the dryer. Waste heat from the kiln is distributed through the dryer by three blowers, and temperatures are closely controlled, being maintained at 100 deg. F. at the feed end and 190 to 200 deg. F at the discharge end. A series of dampers and baffles distribute the hot air. Recording thermometers and wet- and dry-bulb thermometers form a part of the heat control system. Fans are motor-driven by Tex-rope drives, using two 7½-hp. motors and one 10-hp. motor. Transfer cars and track bring the kiln cars to the feed end of the tunnel kiln.

A Harrop car tunnel kiln is used for burning. Including the vestibules, it is 420 ft. in length, the first 180 ft. being used for preheating; and this is followed by an 80-ft. firing section and a 147-ft. cooling section. Side walls are 36 in. in thickness, the section being 13½ in. firebrick and 13 in. common brick with 9½ in. insulation in the form of pulverized diatomite between.

Four stations are provided for entrance to the track tunnel. A hydraulic pusher bar moves the cars through the tunnel. Closed vestibules are provided at both ends. Seven pressure burners on each side of the firing zone supply the firing zone. Gas is used at 8-oz. pressure and air is supplied at 14-oz. pressure by a 1,200-cu.ft. per minute General Electric direct motor-driven high-pressure centrifugal compressor, drawing its air supply from the track space and keeping the temperature of this zone below 300 deg. F. In addition, five atmospheric burners on each side are supplied to heat the bottom courses. Gas is supplied at 3-lb. pressure and reduced to 8 oz. by a pressure regulator.

Heating and cooling gradients are shown in the graph of the temperature chart. Gaseous products of combustion move opposite to the direction of the car travel and preheat the incoming cars, finally reaching side ducts by which they are removed by an exhaust fan and discharged into a stack at a temperature of 450-500 deg. F. When the cars pass the firing section, cooling air is drawn in through side ports and is withdrawn by an exhaust fan and discharged into an insulated flue above the tunnel arch and delivered to the dryers.

Temperatures at the beginning of the firing zone are 2,180 deg. F. and reach an intensity of 2,300 deg. maximum (2,550 deg. F. by optical pyrometer). Temperatures are taken hourly at 24 points by a Wilson Maeulen pyrometer. At a rate of ten cars per day, 9,000 cu.ft. of natural gas per hour is used; at 20 cars per day, gas consumption reaches 12,000 cu.ft. per hour. The rate of movement is 60 ft. per 24 hours on the basis of ten cars per day.

Connected horsepower upon the kiln is 50. Exhaust fans are of the American Blower type. Maximum kiln capacity is 36,000 equivalents to 9-in. firebrick. Each kiln car is provided with a 2-in. refractory base and two inches of insulation. Side seals are provided by thin plates which move in a channel filled with rounded pea-size gravel. Each car is loaded with 1,700 to 1,800 brick. After removal from the kiln the cars are transferred to an unloading point and the brick moved to the storage sheds. When in full operation the plant employs 50 to 60 men. As a result of systematic operation under closely controlled conditions, firebrick of almost perfect quality is turned out.

The electrical installation is an important factor in the satisfactory operation of a plant of this kind. At the switchboard 440-volt current is delivered to ten feeder circuits with provision for additional circuits. Seven circuits supply process and conveyor motors, two go to supplementary switchboards, and one serves the lighting circuit. The main switchboard is of steel construction with oil-switch control for main feeder and heavy subfeeder circuits and fused switch control for smaller feeders. Service switchboards consist of steel assemblies carrying fused disconnecting switches with magnetic contactors mounted upon the rear of the panel. Motors on group circuits have magnetic contactors and pushbuttons mounted near the motors. All motors except two are started by pushbutton magnetic control, hand compensators being used upon the motors of the centrifugal compressor and the grinding pan. Conveyor systems are interlocked. Three shuttle conveyors are provided with power leads of three-conductor flexible cords and two heavy-duty plugs and receptacles which are wired to facilitate motor reversal. Plant lighting is provided for by several transformers. Standard R.L.M. dome reflectors are used throughout the plant.

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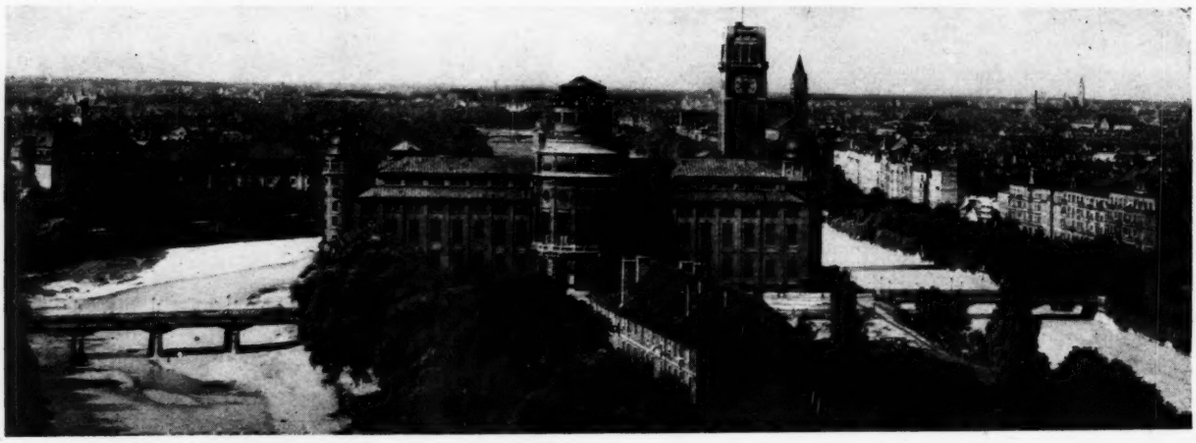


**Industrial Museum at Munich**

# Shaft-Sinking Equipment—II

Lucien Eaton

THE disposal of waste is an important consideration, and the plant required depends upon the uses, if any, to which it may be put, and upon the topography. If the rock from the shaft is of suitable character, it may be used as material for concrete or for road construction, in which case storage bins will be required and dumping will be at a higher level. If the collar is to be raised above the level of the surface of the land, waste rock may be used for filling around the shaft, for railroad embankments for the loading tracks, or for floors for stockpiles or timber yard.

If the rock from the shaft has no economic value, it is wasted at the most convenient point. This may be at the collar, if the topography is favorable or if the material is to be hauled up an incline to the dump in a skip or car. Otherwise it must be trammed at a higher point on a trestle.

Waste from shaft sinking is commonly trammed by hand in small cars, unless the permanent headframe has been erected and the permanent equipment is ready, in which circumstance large cars moved by locomotive or rope haulage are likely to be used. In any event, temporary equipment should be selected, if feasible, of such size, design and track gage as will be suitable for use in the permanent plant either on surface or underground.

The waste dump should be placed in such a position that it will not interfere with future operations or plant, and ample room should be allowed. A factor of 15 cu.ft. per ton and slopes of 35 deg. are usual.

The use of a suspended stage for timbering in the shaft, common in the United States, has many advantages, especially in large shafts of broad rectangular or circular section. For convenience in placing the timbers, as well as for support of the walls, it is customary in rectangular shafts, when a stage is not used, to keep the timbering close to the bottom at all times, leaving out the dividers only, as these are likely to be bent, broken, or displaced by blasting. The dividers are put in periodically and are kept within 20 to 40 ft. of the bottom.

If a timbering stage, or Galloway stage, as it has been named, is used, to sink further below the timber may be safe and economical, as all the timbering can be done from the stage. The dimensions of the stage can be as large as the outside dimensions of the shaft sets; but ordinarily they should be 6 in. smaller in each direction than the corresponding inside dimension of the shaft sets, thus giving 3 in. clearance all around, so that the stage can be hoisted out of the way during blasting. It will thus protect the dividers and other equipment from flying rock, and can be used as a working platform as well, without suffering too much damage itself. In this case the end plates and wall plates are protected from blasting by logs, hung just under them in the loops of small chains.

The stage may be suspended by two ropes with chain bridles or by three ropes hung from chain blocks, which are attached to shaft sets or to beams on surface; or it may be handled by a double-drum hoist. If chain blocks are used they should have quick action and ample capacity, and should be attached to the rope by means of clamps, which can be moved up on the rope periodically as the stage is lowered. Somewhat similar clamps must be provided for holding the rope at the collar of the shaft while the upper clamps are being moved.

The stage itself consists of a framework of steel I-beams or channels,

This is the fourth of a series of articles on mine equipment.

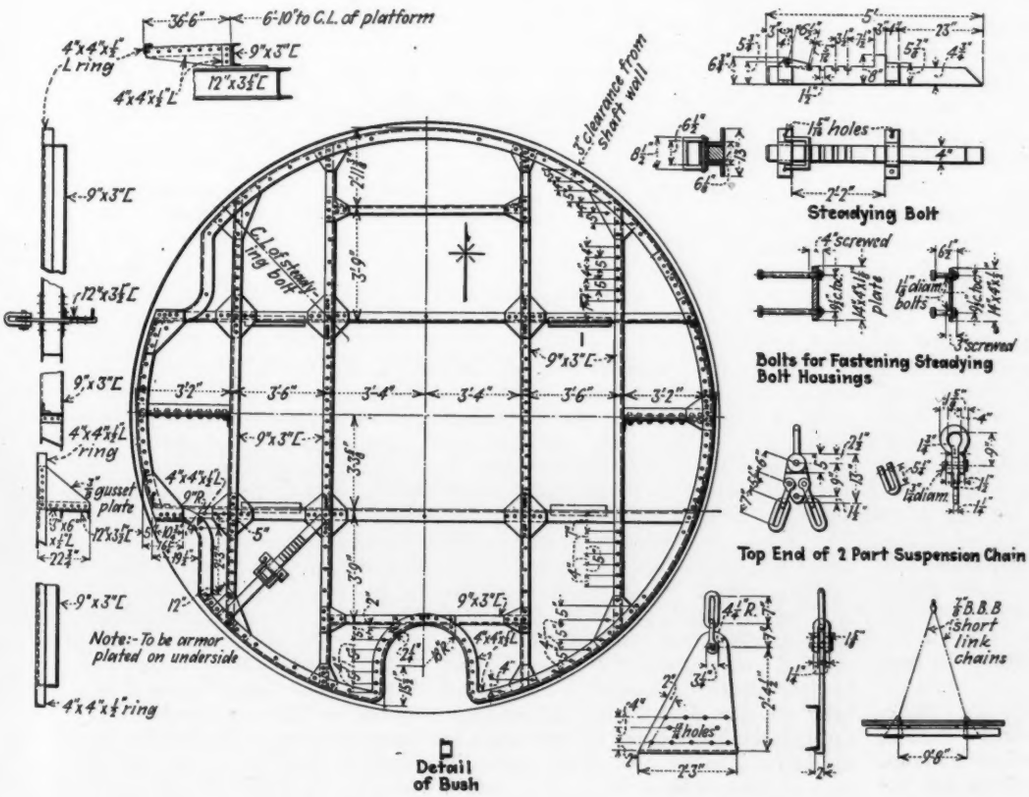
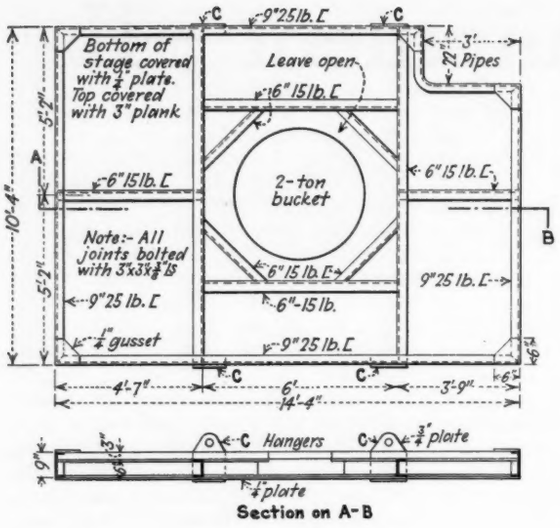



**Fig. 20a—Galloway timbering stage used by Crown Mines in sinking circular shaft on the Rand**




Section on A-B

**Fig. 20b — Typical Rand Galloway stage**

covered on top with plank and underneath with plate. Sometimes the covering on both top and bottom is made of perforated plate. This allows the gases from the blast to pass through easily, but otherwise detracts from the usefulness of the stage. The wooden floor affords a satisfactory foothold for the workmen, permits small sprags to be nailed to it for steadying the stage during timbering, and is easily repaired when broken. Examples of stages are shown in Fig. 20.

Openings are left in the stage for the passage of the pipes providing air, water and ventilation, or trap doors are provided for them. The end of the ventilating pipe should be below the stage after blasting, so as to get the fumes out quickly.

In a circular shaft a Galloway stage is almost a necessity. It is suspended by two ropes with chain bridles, and is made 6 in. smaller in diameter than the inside diameter of the shaft lining if the shaft is lined with concrete blocks; or 12 in. smaller if the lining is of monolithic concrete poured behind forms. If two buckets are used, there are four suspension ropes in line, each with a bridle, for these ropes serve as guides for the crossheads, as is shown in Fig. 14. The stage is handled by a double-drum or quadruple-drum hoist, geared to have great power at slow speed. On the Rand a standard double-drum sinking hoist with 8-ft. drums and 16½x33-in. cylinders is altered by the addition of intermediate gearing so that the gear ratio is increased to something between 16 to 1 and 28 to 1. Two additional drums are added if two buckets are used. Adjustments of the lengths of the ropes, to keep the stage level, are made by adjusting bolts on the bridles or by putting pieces of burlap or hemp under the rope as it winds on the drum.

A typical Rand Galloway stage, shown in Fig. 20, is the stage used in sinking No. 16A shaft at Crown Mines. Note that openings have been left for the ventilating pipe and for the water column.

Four steadying bolts, or "putter bars," as they are locally called, can be extended beyond the line of the shaft for supporting the stage while the walls are being bricked up. The load on the stage is heavy at this time, and there is considerable shock from dumping bucket loads of brick and concrete on it. The "putter bars" rest on the brickwork, and are moved up periodically. To center the stage during sinking and to keep it from swaying it is easier to place sprags against the walls and nail them to the floor of the stage than to use the "putter bars."

The ropes by which the stage is suspended are 1 in. in diameter, 6x7, either regular or Lang lay, and terminate in a socket to which the chain bridles are attached. The socket also serves as a stop block for the crosshead. The crossheads are of the type shown in Fig. 14 (see previous article), and have brass-lined shoes.

Instead of leveling off a base, on which to build up the shaft wall, the use of a concrete curb ring is preferable. The sectional steel forms used for making the ring are shown in Fig. 21. The eleven sections in a 20 ft. 6 in. shaft are each made of a vertical ¼-in. plate, 21 in. high, rolled to an arc of a circle with 10 ft. 3 in. radius, reinforced at top and bottom, and having a flange 9 in. wide, made of ⅜-in. plate, near the bottom on the convex side. The sections are joined by butt straps, and provision is made for removing one section ahead of the rest. In each vertical plate are two 2-in. holes, and under each hole in the flange is a 1¼-in. slot, 6 in. long.

When a curb ring is to be set, light blocking is placed around the bottom of the shaft, and the steel forms are assembled and roughly centered and leveled on this blocking. Horizontal holes are then drilled with jackhammers through the holes in the vertical sides of the forms into the rock of the walls. In each of these holes a short piece of drill steel is driven, the end being inside the line of the plate; and over this piece of steel an eyebolt is slipped, the end of which passes through the slot in the bottom flange. Nuts and washers are put on the eyebolts, and the blocking is removed. The forms can now be easily, quickly, and accurately leveled and centered. Credit for the development of this technique is due to Mr. John Becker, formerly in charge of shaft sinking at Crown Mines.

Two sets of forms are provided, and the lower set is always left in place until the next section of lining has been built. The forms protect the green concrete from blasting and sustain little damage themselves.

Two of the principal objections to the sinking of circular shafts have been the delay caused by pouring monolithic concrete and the difficulty of accurately setting the dividers or the stubs to which they may be bolted later. Both of these objections are almost entirely removed by the use of concrete blocks and the equipment described in the foregoing.

When the shaft has been sunk as far below the lining as is considered safe, a round is blasted but is not mucked out, the broken rock is leveled off, and the curb ring forms are sent down, assembled, centered, and leveled. This takes four to six hours. The stage is lowered to the level of the ring, the hole in the floor being covered with a steel plate, and concrete, not too wet, sent down in a bucket, is dumped on the stage by a snubbing chain attached to one of the suspension ropes. The concrete is shoveled into the curb ring forms and tamped. It sets quickly, and walling can be started immediately. The concrete blocks and the mortar for them are sent down separately in the bucket, and dumped on the stage. The blocks are laid with ½-in. joints, and the space behind them is filled with concrete. Extreme accuracy is not necessary, and alignment can be maintained by lines stretched from the lining in place above to the curb ring below. At the places where the dividers are to be set, bricks are omitted, leaving a hole large enough for alignment of the steel work later.

The dividers are set at 10-ft. intervals. If the joints are ½ in. thick and the blocks are 6 in. thick, nine rows of blocks will make 10 ft. of lining, any adjustment necessary being made by varying the thickness of the joints. The blocks, cast on the surface in collapsible molds, are allowed to cure thoroughly before being sent underground. They are usually 6 in. thick, 9 in. wide, and 12 in. across the back, the front being shortened somewhat according to the diameter of the shaft. A mixture of 4:2:1, using washed sand and clean crushed rock that will pass a 1½-in. ring, makes satisfactory blocks. The same concrete mixer as is used for making the blocks is used for mixing the mortar and the concrete placed behind the walls. A

¼- or ½-yard mixer is required, according to the size of the shaft. If the sections of walling are not too short, 17 ft. per shift can be walled up in a 20-ft. shaft, delay in short lifts being caused by setting the curb ring and making a joint with the wall above. (See "Sinking No. 16A Shaft at Crown Mines," by A. J. Walton; Empire Mining and Metallurgical Congress, South Africa, 1930.)

When the shaft has been sunk to the depth desired, the placing of the dividers, guides, and pipes is begun at the collar and continued downward. The Galloway stage is used as a working platform. When the work has been finished, it is taken apart and sent to surface.

To facilitate erection, the dividers are in two pieces. Each end is slipped into its proper place, and the two parts are then joined by substantial fishplates. The divider is then wedged into its exact position, and the holes left in the walls are packed with concrete. In this way as much as 1,000 ft. of shaft has been "equipped" in a month.

If the shaft is lined with monolithic concrete, as great a height is sunk below the lining as is safe. A round is then blasted, and the broken rock is leveled off. On top of the loose rock a sectionalized wooden form is placed, its inside diameter being that of the finished shaft. When this form has been correctly set, sectionalized steel forms are placed against it, and concrete is poured behind them. The steel forms are made of ⅛-in. plate, stiffened at the edges and across the middle by 2x2x¼-in. angles. Sections are 4 ft. deep, and there are nine to twelve of them in a 20-ft. circle. The horizontal joints are bolted together, and the vertical joints are held together by two ⅝-in. bolts and two taper pins. All but two of the vertical joints are made metal to metal, but these two have ⅞-in. wooden strips between the flanges. When these strips have been cut out, the section in between can be readily removed. Forms are greased on the side toward the concrete.

If dividers are to be used, boxes, which will form the holes in which they will be set, must be attached to the forms in such a way that the forms can be readily separated from them after the concrete has set. Care must be used to insure correct orientation.

As soon as each ring of forms has been set, it is filled with concrete, sent down in a bucket and poured into place through a funnel or shot down through a 6-in. pipe with movable spout. As much as 40 ft. of shaft can be concreted in a day. (See "The Sinking of Circular Shafts From Surface on the Witwatersrand," by W. G. C. Nixon; Third Empire Mining and Metallurgical Congress, South Africa, 1930.)

The bottom ring of forms is set at such a height that there will be a 2- to 3-ft. gap between the top form and the lining in place above, and this gap is closed with concrete blocks. The Galloway stage is used as a working platform throughout the operation. A larger concrete mixer is required than when the walls are built up with concrete blocks.

If a shaft is dry, to use wet drills may be advisable; but most shafts are wet, and, as the holes are partly filled with water, the sludge can be blown out by air. For this reason most drills used in shaft sinking are of the dry type. In medium or soft ground, large jackhammers are usually used, weighing 35 to 55 lb. In hard ground, however, a 3-in. drifting machine, stripped of shell and equipped with handles and a special backhead, will drill so much faster that its greater weight, about 90 lb., is more than justified. This type of machine can be converted into a drifter and used elsewhere in the mine when sinking is finished.

The number of drills required varies from four in a shaft 6x12 ft. outside of timbers to 15 or 20 in a very large shaft. In a shaft 12x16 ft. in section, ten drills are sufficient. Extra drills should be on hand, however, 30 to 50 per cent above the number in use, and a liberal supply of repair parts should also be kept available, if delays are to be avoided.

The lighter machines will use ⅞-in. hexagon hollow steel, and the heavier ones 1-in. All shanks should have collars, and under normal conditions crossbits with double taper, 5 and 15 deg., should be used. The angle of the cutting edge should be 90 to 105 deg., depending on the hardness of the ground. The wings should be not less than ½ in. thick, except in very soft ground. If trouble is experienced with the hole getting plugged, the opening can be brought out through the side between the wings.

Changes of steel will vary from 1 to 2 ft. in length, and from $\frac{1}{16}$ in. to ⅛ in. in gage. A good average is $\frac{3}{32}$ in. per foot of length. Using this gage change, and starting with a 1½-in. bit on ⅞-in. steel, a 6-ft. hole can be bottomed with a diameter of 1⅛ in. and 1-in. powder can be used. From 150 to 200 linear feet of steel should be kept in service for each machine at all times.

Air hoses should be 1 in. diameter, six ply, with a tough rubber cover and oil-resisting lining, and should not be armored. I favor the wrapped type rather than the woven type. The hoses will be attached to a manifold, and their length will depend on its type. In the Lake Superior Iron Country a manifold that has hooks is customarily used, on which the drills are hung when not in use. These manifolds require hoses only 25 ft. long. In South Africa, on the other hand, the manifolds are mounted on the Galloway stage near the edge, and the hoses for both air and water are hung over the edge of the stage near the wall of the shaft. The usual length is 100 ft. As the bucket is in the center, the hoses are not in its way at all, and are in the right position for drilling the first holes.

A manifold is made of a piece of large pipe, into which ¾-in. nipples are welded. Two types are shown in Fig. 22. One is arranged to be hung under the stage or from the shaft timbers, and to carry the drills as well as the hoses. The other is designed to lie on the stage. Both are equipped with line oilers. A manifold with more than eight connections is likely to be unwieldy. If the number required is much more than eight, use of two manifolds is better. Eight connections will take care of six drills, a blowpipe, and a small pump. Connection between the manifold and the air line is through a 25-ft. length of 3-in. six-ply air hose, in each end of which is fitted

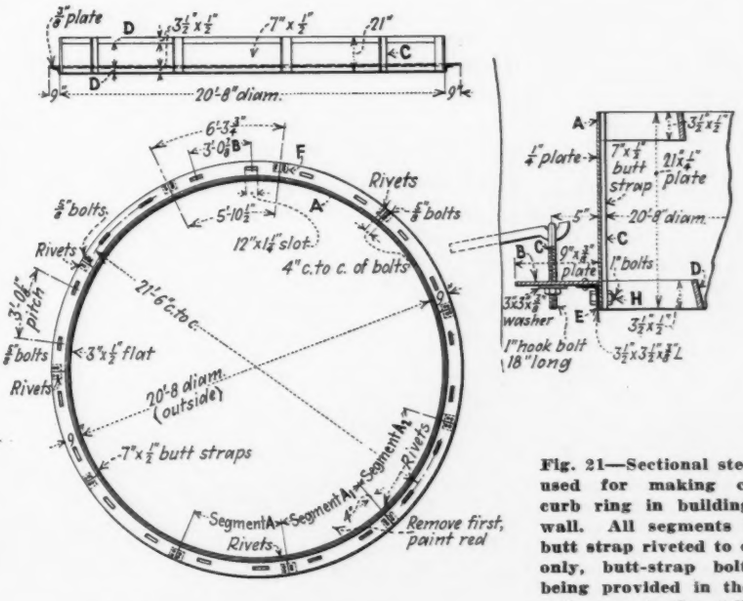



**Fig. 21—Sectional steel form used for making concrete curb ring in building shaft wall. All segments have a butt strap riveted to one end only, butt-strap bolt holes being provided in the other end, except the following: Segment $A_1$, which is removed first, has butt straps riveted to both ends. Segment $A_2$ has no butt strap at either end but has bolt holes instead**

a 2½-in. nipple and union. This union has a brass seat and allows a quick connection to be made.

If the manifold is on the stage, the hoses can be coiled on the stage before blasting. Otherwise, the manifold is hung under the bucket or cage and hoisted directly to surface. If wet drills are used, the Lake Superior type of

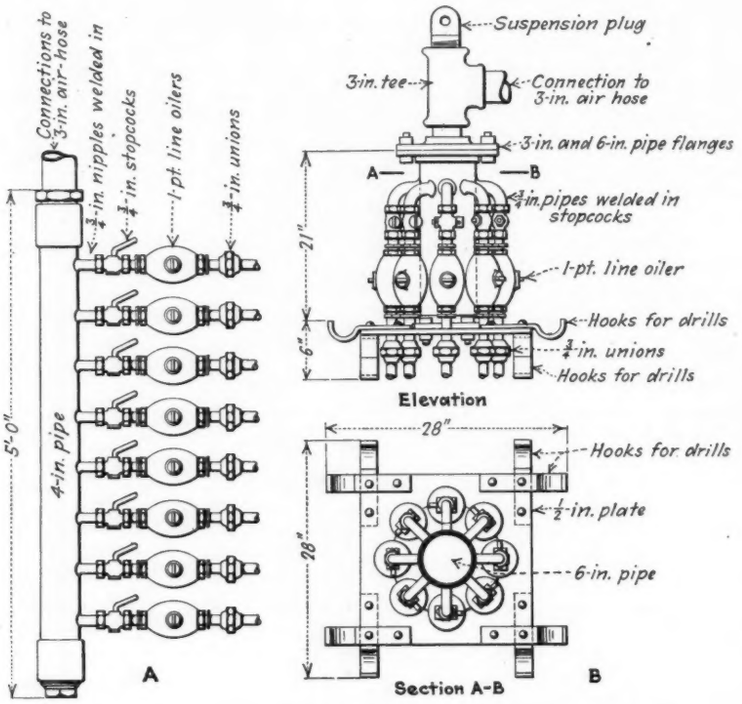



**Fig. 22—Two types of drilling manifold. *A*, horizontal. *B*, vertical**

manifold loses some of its advantages, because the hoses are likely to become entangled. A water manifold is similar in design to that used for air, but is smaller. The water pipe down the shaft should be 1½ in. diameter, so arranged that a head of more than 250 ft. will not develop. A ¾-in. blowpipe should connect to the manifold for blowing out holes; and in large shafts one should be provided for each side of the shaft.

Unless something is known in regard to the amount of water that may be expected in the shaft, the provision of pumping equipment is based on guesswork. If the flow of water is less than 300 g.p.m., Cameron pumps, driven by compressed air, are almost standard equipment. In small shafts, vertical sinking pumps may be necessary, but the standard horizontal pump is cheaper, lighter, and more convenient to handle in the smaller sizes up to the No. 8. Two No. 7 or No. 8 pumps provide a useful combination, and are more easily handled than is a No. 10 pump. The discharge from these smaller pumps should be through a six-ply or eight-ply rubber hose, connected to the bottom of the water column. The suction hose should be wrapped with rope for protection, and the wind bore should be made of pipe or steel, not cast iron.

Electrically driven sinking pumps in both centrifugal and plunger types are on the market. The centrifugal pumps work excellently in unwatering old mines, but are quickly worn out by the gritty water that must be handled in shaft sinking. They serve well as station pumps, however, when the lift has become too great for the sinkers.

Plunger pumps with two or three single-acting plungers, geared to a motor that is mounted above, give excellent service and are much more economical of power than pumps driven by compressed air. They are, however, bulky and heavy to handle, and cannot be lowered directly to the bottom of the shaft, but must be suspended from the shaft timbers. If mounted in a framework that runs on guides in a compartment at one end of the shaft, and if special hoisting equipment is provided, such a pump will prove economical and convenient.

The water column should be of standard pipe, fitted with steel or malleable flanges or with Victaulic joints. Convenience will result if the pipe is purchased in equal lengths that are multiples of the interval between sets, so that the joints will always be in the same position in relation to the shaft timbers.

To remove the smoke and gases produced by blasting, quickly and effectively, some sort of artificial ventilation must be provided. A fan or blower is the usual equipment, but good results are obtained by inspirators, which consist of small jets of compressed air introduced into the ventilation pipe at intervals of about 200 ft.

Difference of opinion exists as to whether or not air should be blown down the shaft or be sucked out of it. The pressure system makes possible the use of collapsible canvas tubing, and sends the fresh air directly to the bottom of the shaft, but it dissipates the gases throughout the upper part of the shaft, and these must be almost completely displaced before a return to work is safe. The suction system, on the other hand, requires metal tubing, but draws the concentrated gases off before they have spread through the rest of the shaft. The gases at the bottom must be thoroughly stirred and diluted by blowing compressed air into them. If water is dropping down the shaft, it will "kill" the gases, but if the shaft is dry, and a water pipe is provided for the drills, a spray from this pipe will prove effective.

A few years ago Capt. John Olds, of the Cliffs Shaft mine, at Ishpeming, Mich., invented a spray that has proved efficacious in removing the gases of blasting from the mine air in stopes, drifts, raises and shafts. It consists of a pipe in which a jet of compressed air meets a jet of water under pressure, and a perforated cap or ball through which the mixture of air and water escapes. The spray is connected to the air lines and water lines. After the blast, it is turned on for about five minutes. It produces a dense fog, which apparently dissolves all the gases and settles all the smoke and dust in a short time. By the use of this spray, drifts and raises have been driven without artificial ventilation for long distances without trouble from smoke or gas.

The capacity of the fan or blower in cubic feet of free air per minute should be at least twelve times the cross-sectional area of the excavation. The pressure required will depend on the size, material, and length of the pipe. Frictional resistance of canvas pipe is materially greater than that of metal pipe, and a larger diameter must therefore be used for the same capacity.

As the shaft is deepened, the length of the pipe, and, consequently, the back pressure on the fan, increases, and the amount of air delivered decreases. In anticipation of this, the characteristics and size of the fan should be such as to deliver the correct amount of air when the shaft has reached three-fourths of its depth. In the first fourth of the depth the discharge of the fan can be choked or its speed reduced, to prevent overloading the motor. During the last quarter, sinking can be carried on with a subnormal quantity of air.

To suck out the gases at first is sometimes convenient; then to reverse the current and blow fresh air down. This can be done by valves with a fan, or by reversing the motor on a blower.

The pressures required are relatively high, and a compromise is reached between the size of the pipe and its frictional resistance. On account of the high

pressures required, screw-type fans are not suitable for deep shafts. The centrifugal type, good for pressures up to 10 oz. per square inch, is preferred.

Blowers of the Root type have the advantage that they will deliver, slip being neglected, the same volume of air without regard to the length of the pipe, the power required increasing as the pressure rises. A slip of 5 to 10 per cent should be allowed in calculating capacity. The first cost of a blower, however, is so much greater than that of a fan that, unless it can be used later as part of the permanent equipment, the extra cost is not justified for shaft sinking alone.

Spiral-riveted pipe is excellent for ventilating pipe, but it is expensive if the first cost has to be borne by one operation. To use pipe rolled from light galvanized sheets is more economical. This may be bought made up, if it has to be transported only a short distance; but if much is required, or the distance is long, to buy the sheets and fittings and the tools for making the pipe, and to assemble at the mine, is more economical. The diameter of pipe chosen should be such as can be made from standard sheets without waste. Diameters of 11 and 15 in. are convenient sizes.

Both efficiency and safety are improved by adequate lighting at the bottom of the shaft, and floodlights are the best equipment for this purpose. The pendant type is used in vertical shafts and the mounted railroad type in inclines. If much water is falling, the light should be protected by a sheet-iron hood. The pendant type is usually tapped for $\frac{3}{4}$-in. pipe for suspension. For shaft work a short nipple is screwed in and a tee is attached to the nipple. In the upper end of the tee an eyebolt is screwed, and the wires enter through the side opening, later filled with insulating compound. The lens should be of heat-resisting glass, 12 to 16 in. diameter, and the light should accommodate a 300-watt lamp.

A good deal of breakage of both lenses and reflectors is inevitable, and for this reason a floodlight with a metallic reflector and without a lens may be preferred, in spite of its lower efficiency. Such a floodlight can be made out of sheet iron or even of a galvanized water bucket, the inside being painted with white enamel or aluminum paint.

In a vertical shaft the lighting circuit is a two-conductor Tyrex or Cab-tyre cable, with No. 14 wires, fastened at frequent intervals to a $\frac{5}{16}$ or $\frac{3}{8}$-in., 6x19 wire rope for support. These are wound together on a reel or windlass at the collar of the shaft or on one of the levels, and are paid out as required. The lower end of the wire rope is attached to the hanger of the floodlight. Before blasting, the cable, with floodlight attached, is wound up on the windlass and removed from the shaft. In an inclined shaft the electric cable is fastened to the shaft timbers, and ends in a socket, 50 to 100 ft. from the bottom, into which the extension cable from the light is plugged. If electricity is not available for power, a small steam-driven turbo-generator, such as is used on locomotives, or a Delco plant, should be provided for lighting purposes.

A change house, or dry, must be provided for the shaft men. This need not be an elaborate affair, but should provide washing facilities, seats, hooks or lockers for clothes, and some sort of drying rack. A quadruple clothes hook, surmounted by a small wire basket and supported by a chain, which passes over pulleys close to the ceiling, takes the place of both locker and drying rack. Street clothes are hung on it during work hours. At the end of the shift they are replaced by the work clothes, which are hoisted into the hot air in the upper part of the room to dry.

A half-round iron trough, 30 in. across, made of $\frac{1}{8}$-in. plate, having the hot and cold water pipes laid on the center line, makes, with 14-in. enameled basins, a fairly satisfactory washing arrangement. On one side the edge of the basin is supported by the rim of the trough, and on the opposite side by one of the pipes.

If the water in the shaft is acid, the shaft men may have trouble with boils, especially on their necks, elbows, and hands. This trouble can be materially decreased by furnishing soft Vaseline, which is rubbed on necks, forearms, and hands before starting work, and by having ready for each man at the end of the shift a basin of warm water, into which a teaspoonful of Lysol, or similar antiseptic, has been poured.

Accommodations for the underground men in the permanent change house should be laid out in units, each providing washing and changing facilities for about twenty men. To use the equipment of two or three of these units for the shaft shinking crew may be possible.

A separate room should be provided for the foremen and shift bosses, and a small first-aid room, equipped with stool, table, supply cabinet, basin, sink, waste pail and stretcher should be provided.

If electric power is used, a small boiler of 10 or 15 hp., like a diamond-drill boiler, may be used as a heating plant. Otherwise, in cold weather, the various rooms will be heated by stoves, and a hot-water heater must be provided for the dry. A 200-gal. hot-water tank will be sufficient for the ordinary shaft crew, unless showers are provided, in which case the size of the tank should be doubled.

An adequate supply of safe drinking water is essential, and is one of the first matters that should be looked into. The source should be thoroughly protected from contamination. If doubt exists as to the purity of the water, a chlorinator should be installed. Automatic chlorinators that need attention only once a day, or even less, often cost little to operate.

Equally important is the preliminary provision of proper facilities for sanitation and personal comfort. These may consist of the ordinary country type or the army type of latrine, or the Johannesburg system of sanitary buckets may be used. The type selected depends on weather and soil conditions, and is not as important as the care that is exercised. Every receptacle or vessel used should be scrubbed and disinfected daily. Attention to these details will help much in maintaining satisfaction among the personnel. If more than one race of men is employed, each should have its separate facilities.

If the shaft to be sunk is in an isolated spot, where access cannot be had to an established repair shop within a reasonable distance, the equipment to be provided must be more elaborate than would otherwise be necessary. It should, if possible, be such that it can be transferred later to the permanent plant when that is built. Drill sharpening and blacksmithing will be done in one shop, and probably by the same men. The blacksmithing equipment will ordinarily consist of a forge and hood, a fuel box and tempering tank, a 300-lb. steel anvil, a swage-block, tongs, sledges, hammers, chisels, swages, punches, flatters and other hand tools, a bench and vise, an iron rack, and a riveting hammer with hose and sets.

The drill-sharpening equipment will consist of a drill sharpener, complete with dies, dollies, formers, and gaging blocks, a drill punch, forge and hood, a tempering tank, an oil-tempering tank, and racks for dull and sharp steel and for unfinished drill steel. If the forge is to burn oil, a storage tank for it should be added. If in the permanent drill shop a pyrometer is to be used to indicate the temperature of the tempering forge, this equipment should be purchased also, so that the shaft may benefit by its use.

The drill sharpener should be of such a size that it can be used later in the permanent shop. For the shaft itself a No. DS3A Gardner-Denver, or a No. 40 Ingersoll-Rand sharpener, will be satisfactory for steel up to and including 1-in. diameter, but will not be as satisfactory for heavier sections as the larger models.

In the machine shop, which may be in the same room with the drill sharpener and the blacksmith, the usual equipment will consist of a small drill press (about 20-in. size) and drills, a pedestal grinder and countershaft, a pipe machine with dies for cutting pipe $1\frac{1}{2}$ to 8 in. diameter, dies, and die stock for threading pipe below $1\frac{1}{2}$ in. diameter, dies and taps and die stock for threading bolts and tapping nuts, a bench and vise, and hacksaw frame, hammers, wrenches, spanners, and other hand tools. A 1-ton and 2-ton chain block will be found convenient.

If electric power is available, shafting

and belts, driven by a 5-hp. motor, should be provided. Otherwise an air-driven pedestal grinder may be used. Die stocks and dies for cutting and threading by hand pipe up to 6 in. diameter may be substituted for the pipe machine. For electrical work the only equipment needed will be soldering irons, a torch, and hand tools, as the bench and vise in the machine shop can be used in this work. The equipment for the carpenter shop for inside work will not be extensive, consisting of a bench and vise, a grindstone, a reversible boring machine driven by compressed air, and the usual hand tools. The circular saw for the permanent shop and a 25-hp. motor to drive it, if electric power is available, will be found very useful.

For outside work, the carpenter equipment needed will be a gin pole, 60 ft. long with 6 in. top; two 6-ft. crosscut saws; axes, bars, hammers, and other hand tools; $\frac{3}{4}$- and 1-in. double and single blocks; and $\frac{5}{8}$-, $\frac{3}{4}$-, and 1-in. hemp rope.

The shops should be all under one roof. If the topography will permit, to house almost the entire plant in one building will prove economical and convenient. A good arrangement is to have the change house at one end, followed by the boilers, engine room, shops, warehouse, and office. Such an arrangement is particularly advantageous in a cold climate, where heating costs are high.

Bulk materials, such as heavy pipe, rails, lumber, shaft sets, guides, and so on are kept in a storage yard close by; and a shed should be provided for stores such as cement, oils, wire rope, electric cables, portable machinery, and carbide.

Repair parts, bolts, pipe fittings, electric and machinery supplies, tools and general supplies should be kept in a warehouse or storeroom adjacent to the office, where a record of their issuance will be easy to keep. For the disposal of stock, except nuts and bolts, shelves are superior to racks or cubby holes.

The office will contain a change room and office rooms for the superintendent, captain, and engineer, and an office room for the clerk. The furnishings, simple, will consist of clothes hooks like those in the dry, wash basins and a sink, two desks, four or five tables, a fire-proof safe, and a dozen chairs. If steam is not available, the place will be heated with stoves.

The condition of the roads, the topography, and the distance from the railroad will determine the amount and kind of transport needed. Heavy trucks, or a tractor and trailers, may be required for transportation of bulk mateials and heavy machinery if a railroad does not reach the plant, or more primitive methods of transportation may be resorted to. Each operation or property must be studied by itself.

For handling ordinary supplies, for general transportation about the plant, and for the transportation of men, a 2-ton truck is handy; but if the shaft is more than 5 miles from town, a 3-ton truck is probably better.

Electric detonators, both instantaneous and delay, should be used in all blasting in the shaft, and should be tested with a galvanometer and dipped in asphalt paint before being used. Best results will be obtained by using a high-power detonator equivalent to a No. 8 cap. The length of the wires on the detonators depends on the depth of the holes, the position of the primer in the hole, and the distance between wires. Wires 8 or 10 ft. long are commonly used. In wet shafts, "waterproof" detonators should be used. Blasting gelatine is the explosive most generally used in shaft sinking on account of its density and resistance to moisture.

Detonation will be from the lighting circuit, and connection between it and the lead wires should be through a single-throw knife switch in a box with a door and lock. It should be arranged so that the door cannot be closed when the switch is closed, but can be closed and locked when the switch is open.

To use bare copper wire, mounted on porcelain insulators, as lead wire, is considered safest, but this is not always possible. A two-conductor 14-gage Tyrex cable may be used between the blasting switch and the loop of the connecting wire attached to the detonators. Such a cable, supported by a small wire rope in the same way as the cable for the floodlights, makes a satisfactory lead wire. In practice, the blaster locks the switch open and keeps the key in his pocket. He does not connect the upper end of the lead wires to the switch until he is ready to shoot.

Caps and exploders may be kept in the warehouse, but dynamite must be stored in a magazine at a safe distance from the plant. A portable steel magazine may sometimes be rented or borrowed from the powder company, or a short tunnel in a side hill may be available. Otherwise, a magazine must be constructed. This must be a windowless, well-ventilated, fireproof building, with walls and door capable of stopping a rifle bullet, with a capacity equal to one and a half times the largest shipment of explosives expected. In order to keep the temperature inside as low as possible in summer, the roof and walls should be painted with aluminum paint. In cold climates, low-freezing powder should be used, so that thawing will not be necessary.

If the shaft is within 10 miles of a town, from which the labor supply is drawn, to carry part of the crew back and forth is usually more economical than to house them at the property. At some mines the men provide their own transportation, and at others they are carried by some outside concern, and the mining company pays part of the cost; or the company may furnish transportation free.

Someone in authority should be within easy call at the property at all times, in case of accident or breakdown, and for this reason a few houses for the captain and some of the foremen, and a boarding house for the men, may be built. Any construction undertaken should, if possible, fit in with the permanent housing scheme.

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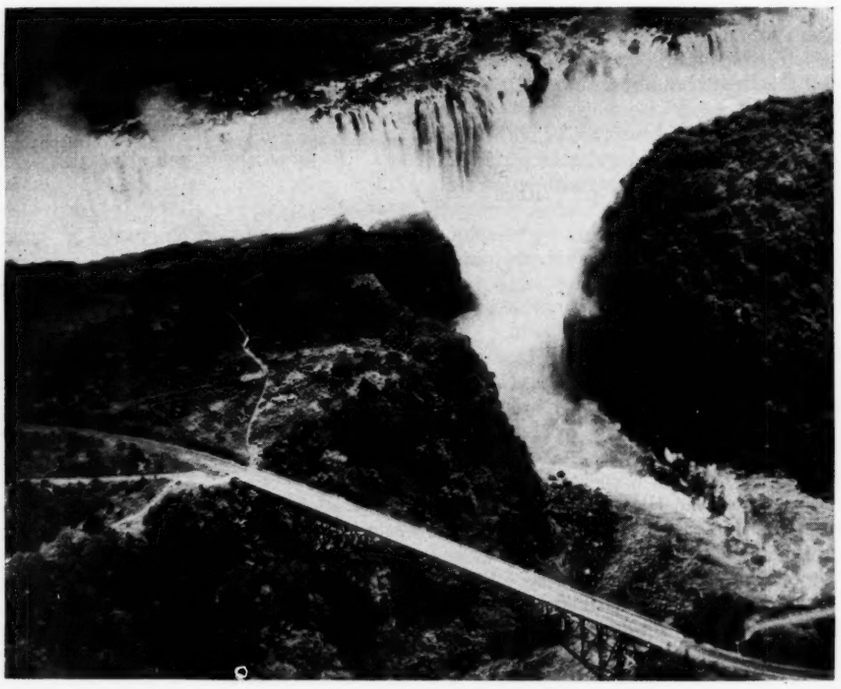


**Victoria Falls, Zambesi River**

# Rock-Asphalt Mining in Texas

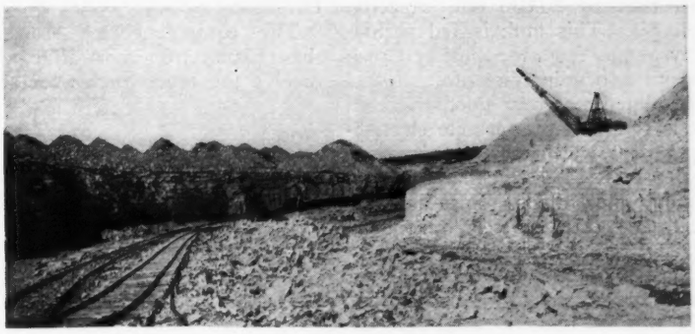
J. B. Huttl

PRODUCTS brought forward in nature's laboratory usually are in an impure condition, and need the help of the chemist and metallurgist to make them available to mankind. In forming the rock-asphalt deposits of Texas, nature for once has made an exception, for here rock and asphalt have been blended in such proportions that only mining and crushing are required to make the material ready for immediate use.

Exploitation of the Uvalde rock-asphalt deposits, about 18 miles west of Uvalde, Tex., dates back to 1894. They occur in the form of beds from 10 to 50 ft. thick, resting in a saucer-shaped structure of sedimentary rock, in close association with masses of igneous rock. The rock aggregate of the Uvalde deposits is limestone—an ideal road-building material. It is a dark gray in color, and contains from 9 to 12 per cent asphalt. The soil overlying the rock asphalt is a soft, whitish limestone, averaging 12 ft. thick.

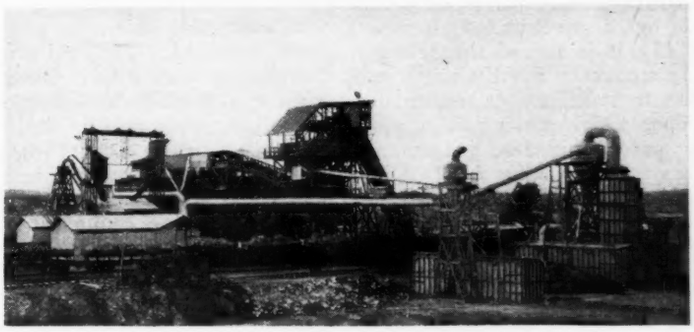
Of the three principal companies active in the Uvalde rock-asphalt belt, the Uvalde Rock Asphalt Company is the largest. The two mines, known as the South and Gato pits, and the crushing plant are near Blewett, Tex., a station on the spur connecting the properties with the main line of the Southern Pacific R.R. at Cline, Tex. A second spur line connects with the branch line of the Missouri Pacific R.R. The Gato pit, favored with high-grade stone, is the principal source of supply for the processing plant. Rock for blending is obtained from the South pit, which is worked intermittently whenever rock of lower grade is required.

Stripping of overburden is done by a Monighan and Browning steam dragline, equipped with a 100- and 70-ft. boom and a 2½- and 2-cu.yd. bucket, respectively. A Browning 1-cu.yd. combination dragline and shovel is available for cleaning operations. All machines are oil-fired. Hard-rock overburden, encountered occasionally, is drilled with IR BCR 480 Jackhamers, using ⅞-in. hexagonal hollow drill steel varying from 4 to 16 ft. long. The drills, sharpened with a drop in gage of ⅛ in., are changed every 2 ft. Drill holes are spaced with 3-ft. centers, and 60 per cent Hercules dynamite is used for blasting.



Gato pit at Uvalde, Tex.

Monighan dragline stripping overburden



Processing plant, Uvalde Asphalt Company

The rock-asphalt bed is exploited by the bench method of quarrying. Each round consists of 60 holes, drilled with 6-ft. centers, from 20 to 30 ft. deep. Skid-mounted IR X-71 drifters are used for drilling. The drills are made from 1¼-in. hollow-round steel. Three sizes are used: starters, 10 ft.; seconds, 20 ft.; and finishers, 30 ft. long. The drop in gage is ¼ in.; that is, the starter contains a 2⅝-in. bit, the second a 2⅜-in. bit, and the finisher a 2⅛-in. bit. Drilling the asphalt rock was difficult prior to the adoption of the specially forged bit shown in Fig. 1. The asphalt content of the rock tended to plug the drillhole and gum the bit proper, with a consequent loss in drilling speed. This difficulty was overcome by forging solid the opening of the normal bit, and by drilling a $\frac{7}{16}$-in. hole between the wings of the bit and about 3 in. from the cutting edge, to meet the central passage.

Drilling is done by Mexican labor. For blasting, 60 per cent dynamite is used. The powder consumption is about ½ lb. per ton of rock broken. Air for drilling operations is furnished by a central compressor plant at the mouth of the Gato pit. It contains an IR Imperial-Type 10 air compressor, driven by a 240-hp. Fairbanks-Morse oil engine, and an IR Class PDC 2 oil-engine air compressor, connected by a 4-in. main to the 2-in. branch lines encircling the pit; the auxiliary equipment such as starter bottles, a closed cooling system, an air receiver, and two small compressors which furnish air for filling the starter bottles; and the conventional drill-sharpening machin-

ery, consisting of an IR 33 and an IR 4 drill sharpener, an oil forge, a drill press, and sundry tools. Water for the compressor plant and the drills at the pit is obtained by gravity from an elevated tank of 20,000 gal. capacity, near the pit. This tank is fed periodically by pumps from the Turkey Creek dam, about two miles distant.

Accumulated water or flood water in the pit is removed by portable electric-driven pumps. Blockholing is done with IR BCR 480 Jackhamers and $\frac{7}{8}$-in. hollow steel drills. Fuse-firing is practiced for primary and secondary blasting.

The broken rock is loaded on 12-ton side-dump quarry cars by two Bucyrus No. 70 steam shovels, mounted on standard-gage trucks, and equipped with 2½-yd. dippers. Each shovel operates on a portable track, which is shifted manually whenever change of location is desired. From the pit floor the loaded cars are hauled in trains by oil-fired, geared Lima locomotives over a standard-gage branch line to the crushing plant at Blewett. A small gasoline-driven locomotive is used for switching.

At the crushing plant the cars are automatically switched by a home-made switch installation, and dumped into the 85-ton hopper-bottomed feed bin installed above the 48-in. steel conveyor serving a Williams hammer crusher driven by a 250-hp. Fairbanks-Morse motor. The rock, crushed to 6 in., is collected in a small concrete sump and elevated by a steel-bucket elevator, whence (1) it is passed through two revolving trommels, fitted with screens according to specifications, which discharge upon a slow-moving 60-in. picking belt; or (2) bypassed and dumped direct upon the picking belt. Ordinarily, from three to eight men are employed in removing low-grade rock and waste from the belt. The high-grade rock is discharged into a hand-controlled distributing feeder, which evenly feeds its contents upon a 32-in. belt conveyor, equipped with a movable tripper, running the entire length of the 2,000-ton wooden storage bin. From the bin a part of the rock is loaded by gravity into gondola cars and shipped direct to the consumer. The remainder is treated in three separate plants grouped around the storage bin, producing pulverized rock asphalt and road-surfacing materials sold under the trade names of Duraco, Uramix and Urabase.

The equipment and flowsheets of these plants are almost alike. All plants receive the crude rock over short steel

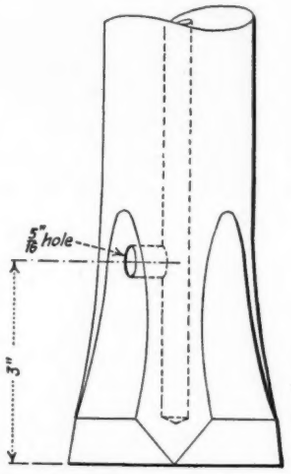



**Fig. 1—Special bit used for drilling rock-asphalt deposit**

pan conveyors, which evenly feed the material to Williams pulverizers driven by 150-hp. Fairbanks-Morse motors. At the plant producing finely crushed rock asphalt, the pulverizer is fitted with adjustable blades, to produce any mesh specified. The pulverizer discharges the fines into a storage sump, whence a steel bucket elevator raises and discharges the finished product into railroad cars. Plants Nos. 2 and 3 contain, besides the aforementioned machinery, a rotary mixer and the conventional sacking equipment.

Oil, water, and trap rock are added automatically in precalculated quantities. The trap rock is obtained from a quarry near Knippa, Tex., and stored in a concrete bin at the mixing plant. From here the material is scraped into the self-dumping skips of the two mixing plant elevators, and then raised and dumped into the elevated storage silos.

The dust problem at the plants has been solved by the installation of a modern dust recovery plant. Collected dust, with from 15 to 20 per cent asphalt per ton, is blown by fans to storage tanks equipped with automatic sacking devices. All sampling is done by hand. Generally, six samples are taken from each car before shipment. A chemical analysis of each sample is made at the laboratory. The total plant capacity is 2,500 tons of rock a day.

Electric power is produced by two 360-hp. six-cylinder and two 240-hp. four-cylinder Fairbanks-Morse oil engines, coupled direct to Fairbanks-Morse a.c. generators and d.c. exciters. The auxiliaries consists of seven starter bottles, an oil filtering plant, two gasoline-driven and one electric-driven Fairbanks-Morse air compressors for charging the starter bottles, a closed water-cooling system with a home-made cooling tower, and a small water-softening plant. The power house also contains a large switchboard, fitted with individual control panels for each engine, and a separate panel connected to the distribution lines of the adjacent Central Power & Light Company's substation.

General repair work and rebuilding of quarry and crushing machinery are done at the shops maintained at the crushing plant. The machine shop is equipped with modern tools and metal-working machines, including oxygen and electric welders. Compressed air for plant use is furnished by a Worthington Ludlow 9½x12-in. air compressor, driven by a 100-hp. Fairbanks-Morse motor, housed jointly with a Fairbanks-Morse 25-hp. auxiliary lighting plant in the extension of the machine shop.

Water for plant operations is obtained from the near-by Turkey Creek, which is dammed at three points. Domestic water is pumped from a series of wells to a 20,000-gal. storage tank. Total fuel oil storage is 250,000 gal. A staff house, school, and medical facilities are available at the company settlement at Blewett. J. B. Smyth is president and Glen H. Alvey is vice-president and general manager of the company. R. B. Smith, general superintendent, is in charge of operations.

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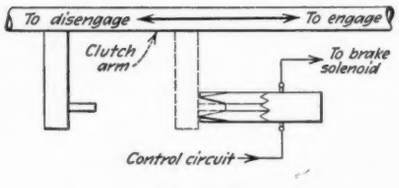
## Simple and Effective Make-and-Brake Clutch Switch

THE chief electrician at the Bingham Mines of the United States Smelting, Refining & Mining Company, in Utah, Mr. C. L. Moore, is responsible for a simple yet effective application of a make-and-break switch, operating directly from the clutch arm of a large double-drum hoist. The accompanying sketch gives the details. It is operated by the clutch push-rod or arm, the switch having a series connection in

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the solenoid circuit. Thus, when the clutch on one drum of the hoist is disengaged, the brake solenoid drops, and the brakes are applied by gravity from a counterweight.

The device as used at Bingham gives full protection while unclutching, as any movement of the clutch arm disengages the switch, allowing the brakes to apply and keeping them applied until the clutch is reengaged.

# Separation of Feldspar From Quartz

**H. G. Iverson**

*Research Fellow Utah Engineering Experiment Station, University of Utah*

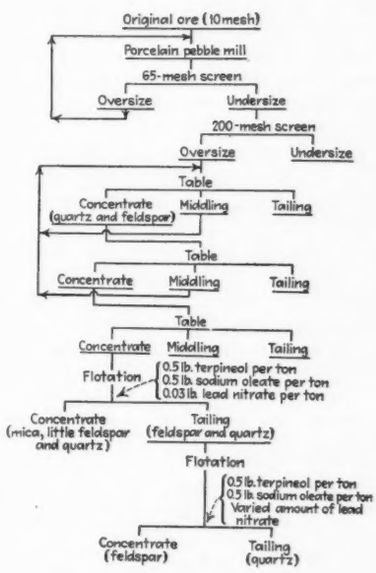
THE material on which separation experiments of the constituent minerals were conducted consisted of a pink granite that had been crushed to about 10-mesh size. The mineral components and their approximate percentages in this ore were: biotite mica, 5 to 10 per cent; orthoclase feldspar, 65 to 75 per cent; quartz, 20 to 25 per cent. Previous work on this problem led to the belief that, if the mica could be removed from the granite, little trouble would be experienced in removing the feldspar from the quartz, at least in laboratory-scale experiments.

Removal of biotite mica from either feldspar or quartz is necessary because of the effect of its iron content on the products in which these minerals are utilized. Hence, the first problem that had to be solved was the development of a cheap and efficient method of separating the biotite mica from feldspar and quartz. A commercial method of separating muscovite mica from a sand containing feldspar and quartz has been evolved within the last two years or so, and is in actual operation in the Spruce Pine district of North Carolina.[1] The method involves tabling the material, thus producing excellent table concentrate of practically pure muscovite mica. Size of the mica in this product is fairly coarse, being about 28 to 48 mesh. This work led to the belief that tabling would also remove the biotite mica. On treating the 10-mesh material, however, no separation of mica from feldspar and quartz was effected.

A large sample of the original 10-mesh ore was then ground in a porcelain pebble mill, and the crushed material separated by screening into the following sized products: minus 20 plus 35, minus 35 plus 65, and minus 65 plus about 560 mesh. These three products were treated separately on a laboratory-size Wilfley table for the removal of the biotite mica. Poor results were obtained on the minus 20 plus 35 mesh material. On the minus 35 plus 65 mesh product, more than 60 per cent of the biotite mica was removed. In the minus 65 plus 560 mesh product, excellent results were obtained, only a small amount of biotite mica remaining with the feldspar and quartz. A loss of the fine feldspar and quartz particles occurred in this last size, however, owing to the fact that these grains in the 560-mesh size are particularly small and hence light, and, under the strong current action of water on the table, were carried away.

Explanation as to why tabling on the coarse material did not produce as good results as on the finer material is, in this instance, self-evident. The coarse biotite mica grains, around 10 to 35 mesh, are nearly equidimensional. Hence, their ease of separation by tabling from feldspar and quartz would depend on the difference in their specific gravities. The specific gravities of the three minerals are: biotite mica, 2.9; feldspar, 2.65; quartz, 2.66. The differences in specific gravity are not great enough to make possible a separation of these minerals by a gravity method.

On finer crushing, through 35, or, better still, through 65 mesh, the thin, platy character of the biotite mica crystals is revealed. This physical characteristic of the mineral is responsible for its separation from quartz and feldspar on tabling. Mica in this form is readily caught and carried off by the water into the tailing and the concentrate will consist of feldspar and quartz,




**Flowsheet of laboratory tests**

with only a small amount of mica. Apparently, this action is not a gravity separation, but a washing or skin flotation effect. If it were a gravity separation, mica should come off the end of the table above and not below feldspar and quartz, as it is slightly heavier than either of these minerals.

As a result of the data obtained from these preliminary experiments, a large sample of the original 10-mesh ore was ground through 65 mesh, in a porcelain pebble mill, producing as small an amount of minus-200 mesh product as possible. This minus-200 mesh product, removed by screening, was examined under a microscope and found to contain little mica, owing to the thin, platy, and elastic surfaces of the mica particles that offer great resistance to fine grinding.

The minus 65 plus 200 mesh material was then tabled to remove the biotite mica. On properly adjusting the water flow and table slope, a sharp separation of biotite mica from quartz and feldspar was obtained. But as the shaking action of the table does not result in exposing all the mica particles in the quartz and feldspar mixture to the action of the water, which would carry the mica particles off, the concentrate still contained some biotite mica after the first tabling. Hence, it was retabled twice, and each time more mica was removed. The final table concentrate contained only a small quantity of biotite mica, the rest being quartz and feldspar, whereas the tailing consisted of almost pure biotite mica. Middling obtained by the aforesaid treatments was fed to the table twice and the final concentrate from this treatment was added to that first obtained. The table concentrate was now ready for treatment by flotation to remove feldspar.

On using the reagents necessary for the removal of feldspar from quartz, practically all of the remaining mica in the charge came up in the froth. On reducing the reagents to sufficiently small quantities, only the mica, with small amounts of feldspar and quartz, was removed. Consequently, the whole sample was treated in this manner by flotation for the removal of the biotite mica left in the table concentrate. The tailing from these experiments contained feldspar and quartz, with only a trace of biotite mica. Consequently, the iron content of this material was negligible. Reagents and the amounts used per ton to effect this separation were: terpineol, as a frothing agent, 0.5 lb.; sodium oleate, 0.5 lb., and lead nitrate, 0.03 lb., as collecting agents.

Results of the tabling and flotation experiments are presented in Table I and II, respectively. The flowsheet is shown in the accompanying diagram. In calculating the results obtained, the percentages of feldspar and quartz in the concentrate, and also the recoveries, were based on the alumina and silica content of the materials. For example, pieces of pure feldspar were analyzed and found to contain 18.3 per cent

[1]Henry, S. T.: *Eng. and Min. Jour.*, Vol. 127, 1929, p. 630.

alumina and 65.8 per cent silica, which amounts agree closely with the theoretical composition of orthoclase feldspar. Hence, any concentrate of this material that analyzed about 18.3 per cent alumina would be assumed to be practically pure feldspar. The analyses employed in making the aforesaid calculations were: feldspar, 18.3 per cent alumina and 65.8 per cent silica; heads, 14.9 per cent alumina and 72 per cent silica; concentrate, 17.5 per cent alumina and 67.3 per cent silica.

The treated material was now ready for flotation to remove the feldspar from the quartz. Before the work was started, however, a few flotation experiments were made on untabled material to determine whether or not biotite mica could be removed directly without tabling. Results were not satisfactory, for when enough reagents were added to float all of the mica, considerable quantities of feldspar and quartz were also brought up.

At this point a description of the manner in which these and the following flotation experiments were conducted may well be presented. The type of cell used was a 50-gram celluloid cell of the design developed by Gates and Jacobsen.[2] Previous to floating, the charge was conditioned in 50 c.c. of water for 4 min. with collecting agents, and 4 min. with the frothing agents. The time allowed for floating varied from 3 to 5 min., the collecting action being rapid. Typical calculations follow:

Weight of concentrate = 42.8 grams; charge 50 grams

$\frac{14.9(100)}{18.3}$ = 81.4 per cent feldspar in heads

$0.814(50)$ = 40.7 grams feldspar in each 50-gram charge

$\frac{17.5(100)}{18.3}$ = 95.5 per cent feldspar in the concentrate

$\frac{(0.955)42.8}{40.7}$ = 100 per cent feldspar recovery

From these figures the theoretical silica content can be calculated, which for this material should agree quite closely with the amount found by chemical analysis.

The concentrate contains 4.5 per cent (100 — 95.5) silica as quartz. Feldspar contains 65.8 per cent silica. Silica in the feldspar in the concentrate amounts to 62.84 per cent (95.5 × 0.658). Theoretically silica in the concentrate is therefore 67.3 per cent (62.8 + 4.5). In this instance the amount found by chemical analysis was also 67.3 per cent. However, if the analysis of the silica content of the concentrate agrees within 2 or 3 per cent of the theoretical value, it is considered a fair check. The percentages of quartz and feldspar were also verified by microscopic examination of several concentrates. The method used in this determination will be given subsequently.

**Table I—Results of Tabling Experiments**

| Material | $Al_2O_3$, Per Cent | $SiO_2$ Per Cent |
|---|---|---|
| Table concentrate, – 35 + 65 mesh | 16.8 | 69.0 |
| Table concentrate, – 65 + 560 mesh | 16.6 | 70.0 |
| Table concentrate, – 65 + 200 mesh | 16.7 | 68.0 |
| Feldspar | 18.3 | 65.8 |
| Heads to flotation cell (for removal of feldspar) | 14.9 | 72.0 |

*Discussion of results:* The heads to the flotation cell, after the last removal of mica, contained only a trace of this mineral, thereby practically eliminating the iron content of this product. This is particularly satisfactory, as iron, even in small quantities, is objectionable in products for which feldspar is used.

Excellent results on the separation of feldspar from quartz were obtained on this mica-free material, as can be seen by referring to Table II. Tests 4 and 5, using 0.25 and 0.3 lb. of lead nitrate per ton, respectively, produced concentrate running from 95.5 to about 100 per cent in feldspar, and recovered 93.4 to about 100 per cent of the feldspar. As will be noted, the use of these amounts of reagents gave the most satisfactory results.

Of especial interest is the fact that the lead oleate, formed in the cell by a combination of the aforesaid reagents, had such a marked attraction for mica, feldspar, and quartz. If a sufficient quantity of these reagents be used, all three of the minerals will come up in the froth; however, if they are added in small and carefully controlled quantities, a differential separation of the three minerals can be obtained with the same reagents.

The effect of lead oleate on feldspar and quartz is not of an erratic nature. In previous work on these minerals, excellent separations of feldspar from quartz were obtained with these reagents on synthetic mixtures of quartz and feldspar, on ground mixtures of quartz and feldspar, and on a North Carolina graphic granite that contained practically only quartz and feldspar. On this latter material, concentrate could be obtained running from 95 to 99 per cent feldspar, with a recovery of from 92 to 95 per cent of the feldspar in the material tested.

Although these experiments were all conducted on a laboratory scale, the belief is held that the results obtained are sufficiently encouraging to warrant trying this method of separating feldspar and mica from quartz on a commercial or semi-commercial scale. If results on such a scale prove to be as satisfactory as those obtained in the laboratory, they would make possible the opening up of new deposits of quartz, feldspar, and mica for commercial exploitation which hitherto have been practically valueless.

*Method for a quantitative microscopic determination of feldspar and quartz:* R. E. Head and M. Slavin developed a method of making hard briquets of fine mineral grains, using bakelite resin as a binder.[3] A. Johannsen and C. A. Merritt developed a method of distinguishing loose feldspar grains from loose quartz grains, by etching the material with hydrofluoric acid.[4] This method is not particularly applicable to fine grains, because of the high magnification needed.

Briquets of pure quartz and pure feldspar, of mixtures of these minerals, and of the concentrates, were made following Mr. Head's method. These briquets were vigorously polished, so as to produce flat surfaces on the mineral particles. These polished surfaces were then etched for two minutes in commercial 48 per cent hydrofluoric acid, washed and dried, and examined under a high-power microscope.

On examining the briquets that contained quartz and feldspar only, a distinct and striking difference was noted in their appearance after etching. The quartz surfaces remained perfectly clear, marred only by a few small etching pits,

**Table II—Results of Flotation Experiments**

Flotation experiments on granite — minus 65 plus 200 mesh, from which biotite mica had been removed. The material contains about 81.4 per cent feldspar and 18.6 per cent quartz. The reagents used were: terpineol, 0.5 lb. per ton; sodium oleate, 0.5 lb. per ton; varying amounts of lead nitrate. All figures represent percentages, unless otherwise stated.

| Test No. | Pb $(NO_3)_2$, Lb. Per Ton | pH | Weight of Concentrate, Grams | $Al_2O_3$ | $SiO_2$ | Feldspar | Quartz | Recovered Feldspar |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.0 | 6.8 | 11.8 | 16.9 | 68.4 | 92.4 | 17.6 | 26.8 |
| 2 | 0.1 | 6.9 | 21.0 | 16.2 | 70.8 | 88.5 | 11.5 | 45.6 |
| 3 | 0.15 | 6.7 | 28.9 | 16.2 | 69.6 | 88.5 | 11.5 | 59.0 |
| 4 | 0.25 | 6.6 | 38.0 | 18.4 | 66.0 | 100.0 | 0.0 | 93.4 |
| 5 | 0.3 | 6.6 | 42.8 | 17.5 | 67.3 | 95.5 | 4.5 | 100.0 |
| 6 | 0.05 | 6.9 | 19.9 | 18.3 | 66.8 | 100.0 | 0.0 | 48.8 |
| 7 | 0.075 | 6.9 | 25.8 | 17.5 | 68.0 | 95.5 | 4.5 | 60.5 |
| 8 | 0.12 | 6.9 | 21.9 | 17.4 | 68.1 | 95.5 | 4.5 | 51.4 |
| 9 | 0.18 | 6.9 | 27.0 | 17.9 | 67.2 | 97.8 | 2.2 | 64.9 |
| 10 | 0.2 | 6.9 | 32.1 | 18.4 | 65.6 | 100.0 | 0.0 | 49.0 |
| 11 | 0.22 | 6.5 | 35.2 | 18.4 | 66.0 | 100.0 | 0.0 | 86.5 |
| 12 | 0.1 | 6.7 | 22.4 | 17.7 | 66.8 | 96.7 | 3.3 | 53.2 |
| 13 | 0.12 | 6.9 | 26.1 | 18.2 | 66.0 | 100.0 | 0.0 | 64.1 |
| 14 | 0.15 | 6.9 | 24.2 | 17.4 | 66.8 | 95.5 | 4.5 | 51.7 |
| 15 | 0.18 | 6.9 | 25.3 | 17.5 | 66.7 | 95.6 | 4.4 | 59.5 |
| 16 | 0.2 | 6.8 | 29.5 | 18.4 | 65.0 | 100.0 | 0.0 | 72.5 |
| 17 | 0.075 | 6.9 | 17.3 | 17.6 | 67.1 | 96.2 | 3.8 | 40.8 |

[2]Gates, J. F., and Jacobsen, L. K.: "Some Flotation Fundamentals and Their Practical Application"; Utah Engineering Experiment Station, Department of Metallurgical Research Bulletin 16, Aug., 1925, pp. 38-56.

[3]Head, R. E., and Slavin, M.: "A New Development in the Preparation of Briquetted Mineral Grains"; Cooperative Technical Paper 10, Bureau of Mines and Department of Mining and Metallurgical Research of the Utah Engineering Experiment Station, 1930.

[4]Johannsen, A., and Merritt, C. A.: *Journal of Geology*, Vol. 34, No. 5, 1926, pp. 462.

whereas the feldspar in every case was colored from a dove gray to a dense black.

This unusual coloring effect was perhaps due to a coating of aluminum-fluosilicate produced by the action of hydrofluoric acid, which rendered the surfaces non-reflective. This characteristic differential-etching effect was borne out in every briquet examined. The difference in the appearance of quartz and feldspar was so marked that the feldspar could be distinguished readily from the quartz in briquets containing a mixture of these two minerals. On closely examining the briquets and counting the areas of quartz and feldspar in the same fields, the percentage composition of each of these minerals was obtained, which agreed fairly closely with the results calculated from the alumina and silica content.

This method of analysis is certain and fairly rapid, as well as accurate, if the observer exercises a little care in estimating the areas occupied by each of the minerals present.

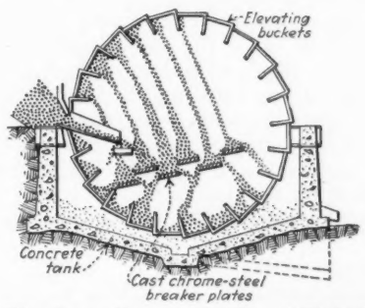
*Conclusion:* Laboratory experiments show that a practically complete separation of quartz and feldspar by flotation is possible. Flotation follows proper grinding and uses oleates as collecting reagents.

■ ■ ■

# Gravity Milling Unit

## Developed in California

STUDIES were recently made by R. G. Hall, San Francisco metallurgist, of the Hadsel gravity mill in operation at the Beebe mine, near Georgetown, Calif. The mill consists essentially of a short length of cylinder, provided with buckets on the inner periphery; breaker plates, independent




**Diagrammatic cross-section of Hadsel mill in action**

of the cylinder, on which the contents of the buckets discharge; a classifier-tank base, also independent of the cylinder; means to feed ore to the buckets, and means to revolve the cylinder.

Mr. Hall's report, made public by the J. E. Knapp Company, is summarized as follows: The Beebe mill is a duplex unit, as shown in the accompanying drawing. Mill diameter is 24 ft. Speed, 2.66 r.p.m. Buckets, 3 ft. square by 3 ft. deep, are 3 ft. apart. The wheel is of steel plate. Breaker plates of chrome steel, supported by 1¾ in. bolts from the outer concrete wall of the classifier tank, project into the inner space of the overhung wheel, but are independent of the wheel structure. The tank classifier is a part of the concrete foundations. Motor drive is by double-reduction spur gears, motor and gearing being between the two overhung units. The motor is 100 hp.

Ore used in the crushing tests was taken from the Beebe mine during development and contained some waste rock. It is silicified and altered, but is above the average Mother Lode ores in hardness. Maximum ore drop is 16 ft. When the radius is at 45 deg. above the horizontal, ore begins to slip off the bucket; allowing for the 15-deg. upward tilt of the bucket plate, the 30-deg. angle appears to be the beginning of discharge, and from this point discharge is continuous until the bucket bottom reaches the vertical position, or 60 deg. of travel. The trajectory of the falling rock has been determined so that the last portion of the discharge just reaches the last breaker plate. Average fall is less than the maximum of 16 ft. During the greater portion of the discharge, much of the water remains in the buckets with the ore and what falls out is sufficient to keep the material from piling up and forming deep cushions on the plates. A tendency is noted for the material to build up on the last breaker plate, but a small amount of water corrects this. The water is fed to the mill in part with the feed, but the greater proportion runs into the classifier tank alongside of the buckets. Results of three tests are given in the accompanying table.

Mr. Hall in his report cities a significant saving in power, as contrasted with the power required for rock breaker, crusher, and ball mill in series to produce a similar result, but points out that a rock breaker will probably be required ahead of the Hadsel mill, to reduce ore to 12 in. He expresses the opinion that, in grinding preparatory to flotation, as close a control on grain size can be obtained as with ball mills, and that the amount of sulphide slime produced is materially lessened.

Also, the size of particles of gold will not be reduced, and native gold sufficiently coarse to be amalgamated may, by proper adjustment of the classifier action, be retained in the tank, and thus concentrated to a much smaller bulk before amalgamation or other process of recovery is applied. Metallic gold too fine or too closely associated with sulphides to be retained in the classifier tank can be recovered in the overflows by cyanidation or flotation.

Abrasive wear, Mr. Hall avers, should be about 0.1 to 0.2 lb. per ton ground for steel plates and manganese-steel bucket lips. Wear of breaker plates should not exceed in pounds of metal the normal wear on a ball-mill lining. He thinks that the wear on lips, buckets, and breaker plates should not exceed 0.5 lb. steel per ton of ore ground. Additional operating data are as follows: Power, per ton, 6.7 kw.-hr.; water, per ton, 1,500 gal.; repairs other than steel, per ton per annum, $0.01.

**Hadsel Mill Tests at Georgetown, Calif.**

| | Mine-dump ore | | |
|---|---|---|---|
| | Unoxidized | Oxidized | Unoxidized |
| Water, g.p.m. | 190 | 300 | 380 |
| Pulp density, per cent solids | 21 | 13 | 11.66 |
| Horsepower | 94 | 87 | 98 |
| Input power | 109 | 101 | 114 |
| Tons per 24 hour | 209 | 280 | 308 |
| Power input, per ton-kw.-hr. | 6.6 | 6.6 | 6.7 |
| Screen analysis of product: | | | |
| on 60 mesh, per cent | 1.27 | 3.0 | 3.0 |
| on 80 mesh, per cent | 6.80 | 11.6 | 9.0 |
| on 100 mesh, per cent | 3.23 | 4.2 | 4.2 |
| on 150 mesh, per cent | 8.75 | 10.4 | 8.4 |
| on 200 mesh, per cent | 8.92 | 9.4 | 10.2 |
| through 200 mesh, per cent | 71.03 | 61.4 | 65.2 |

# Electric Power and Underground Milling at Gilman, Colorado

R. E. Kirkhuff

ELECTRIC POWER for the operation of all plant and equipment at the Gilman, Colo., property of the Empire Zinc Company, a subsidiary of the New Jersey Zinc Company, is furnished by the Public Service Company of Colorado. The system of transmission lines, substations, and generating station is shown in Fig. 1.

Previous to building the new underground mill at Belden—just below Gilman, in the Eagle River Canyon—power was delivered to the property over the 13-kv. Wheeler-Minturn transmission line, which ties in at Wheeler with two parallel 13-kv. lines from Dillon to Kokomo. The section from Wheeler to Minturn is about 20 miles long and traverses extremely rough country that is difficult to patrol. Power was metered in a small sheet-metal house, about 100 ft. southeast of the surface tram hoist house, and then distributed by Empire Zinc at 13 kv. to its five substations, where it was stepped down to 440 volts and distributed to the various motors and equipment.

Two circuits were run from the metering house, one to substations Nos. 1, 2, 3, and 4, the other to substation No. 5. No. 1 substation, with a capacity of 300 kva. and situated near No. 1 shaft, furnished power and light for underground mine operations. No. 2 substation, of 150-kva. capacity, near No. 1 shaft, supplied power and light for No. 1 shaft hoist and shops on the surface at No. 1 shaft. No. 3 substation, of 225-kva. capacity, along the Ocean-to-Ocean Highway and near a new switching and metering house at Gilman, furnished power and light for the town, surface-tram hoist, and shops near the hoist. No. 4 substation, of 300-kva. capacity, near the compressor house at Belden, south of Eagle River, furnished power to the air-compressor house. No. 5 substation, of 87-kva. capacity, about 150 ft. southeast of Black Iron shaft, furnished power and light for surface and mine operations at that point.

When a decision was reached to build the underground mill, data on the new power requirements were submitted to the Public Service Company, and a 90-kv. line, described in detail in *Electrical World*,[1] was constructed between Leadville and Gilman by way of Climax and Robinson. This line, supported on wood-pole structures, with unbonded hardware and no ground wires, is 30.4 miles long and traverses a rugged, mountainous terrain. Its lowest elevation is 8,724 ft. above sea level and the highest, at Fremont Pass, on the Continental Divide, is 11,289 ft. Winter climatic conditions prevail the greater part of the year. Precipitation is generally in the form of snow, which, however, collects on the wires to only a limited extent, as it is dry and soon blown away. Snowslides are frequent at certain points, but these, of course, were avoided in erecting the line. Winter temperatures go as low as 50 deg. below zero Fahrenheit. Winds reach high velocities, but are not cyclonic. In the brief summer period, sudden showers, accompanied by lightning, are frequent. The lightning, however, is not the vicious type.

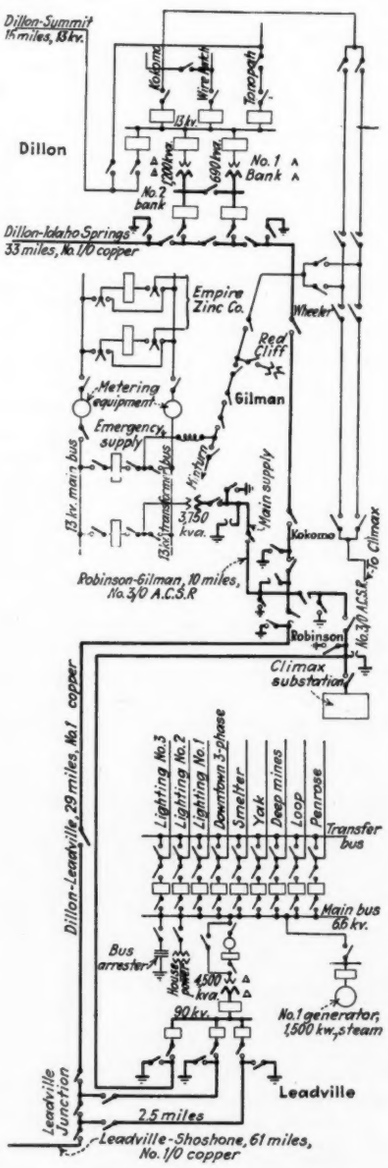



**Fig. 1—Diagrammatic sketch of power transmission lines**

At Belden, a new No. 4 substation, with a capacity of 3,000 kva., was built to furnish power for the new underground mill. The old No. 4 substation at Belden was removed. Between the Gilman switching and metering house and the new No. 4 substation at Belden, a new line was constructed along the incline surface tram, and the old line

Two climatic factors favor the use of wooden structures for supporting the line. The first is the absence of sleet and the other a comparatively dry atmosphere. A sleet storm has never been experienced in this region on any of the existing lines, some of which have been in use for twenty years. The low humidity and high altitude give the wood an excellent seasoning and preservative treatment that results in long life. For instance, wooden mine buildings in the district, built 50 years ago and never painted, are still standing in relatively good condition, even though they have not been occupied for many years.

Simultaneously with the erection of the 90-kv. transmission line, a three-phase 60-cycle, 3,750-kva., 90- to 13-kv. transformer was installed at Gilman to supply the towns of Red Cliff and Minturn, as well as the requirements of Empire Zinc at Gilman, Belden, and Black Iron. The Wheeler-Minturn line, between Red Cliff and Wheeler, is now used as an emergency line. The company also erected a brick building at Gilman to house the 13-kv. switching and metering equipment belonging to the Public Service Company and Empire Zinc. This building supplanted the metering house, southeast of the surface tram hoist house, and provided better switching and protection for the lines of both companies.

[1] "Rocky Mountain Line Construction," by L. M. Robertson; Sept. 14, 1929, Vol. 94, No. 11, pp. 522-5.

This is another of a series of articles on the operations of The Empire Zinc Company at Gilman, Colo.

from Belden to the old No. 4 substation, which traversed particularly rough country, was removed.

The 13-kv., 3-phase, secondary line from the Public Service Company's 3,750-kva., 90- to 13-kv. substation at Gilman passes into the adjacent switching and metering house, where it is connected through an oil circuit breaker and disconnecting switches to a main bus and an auxiliary bus. From these buses, distribution is made to the Minturn-Red Cliff line of the Public Service Company, and to the two lines of Empire Zinc, one of which feeds Nos. 1, 2, and 3 substations, and the other Nos. 4 and 5 substations. The switching and metering equipment for the lines of Empire Zinc is situated in a separate half of the building, and the power furnished to these lines is metered in both buses by metering equipment in the Public Service Company's half of the building. This power is also metered by Empire Zinc, the metering equipment being situated in each of the two outgoing lines.

Switching is accomplished by means of an oil circuit breaker and two selector disconnect switches in each line, arranged so that the power can be fed through the oil circuit breaker from either bus or through the selector switches only, with the oil circuit breaker entirely cut out of the circuit for inspection or repairs.

The present No. 4 substation, at Belden, north of the boiler house, replaces the substation of the same number previously described and situated on the south side of the Eagle River. It was built at the same time as the new mill to take care of the increased power requirements. Equipment in the building includes two parallel banks of three 500-kva., single-phase transformers and a 17x26-ft. switching and metering house. The substation is fed by the 13,000-volt, three-phase line from the Gilman switch house, and steps down the voltage for 440-volt, three-phase, three-wire distribution. Each transformer primary is connected to the high tension bus through two single-pole disconnecting switches. The secondaries of each bank are separately connected to a bus in the switch and meter house through a set of single-pole disconnect switches, a three-pole carbon circuit breaker, and another set of single-pole disconnect switches. This switching arrangement allows the transformer banks to be disconnected readily on both primary and secondary sides and also permits the circuit breakers to be cut out for inspection or repairs. Overload protection is provided by the carbon circuit breakers.

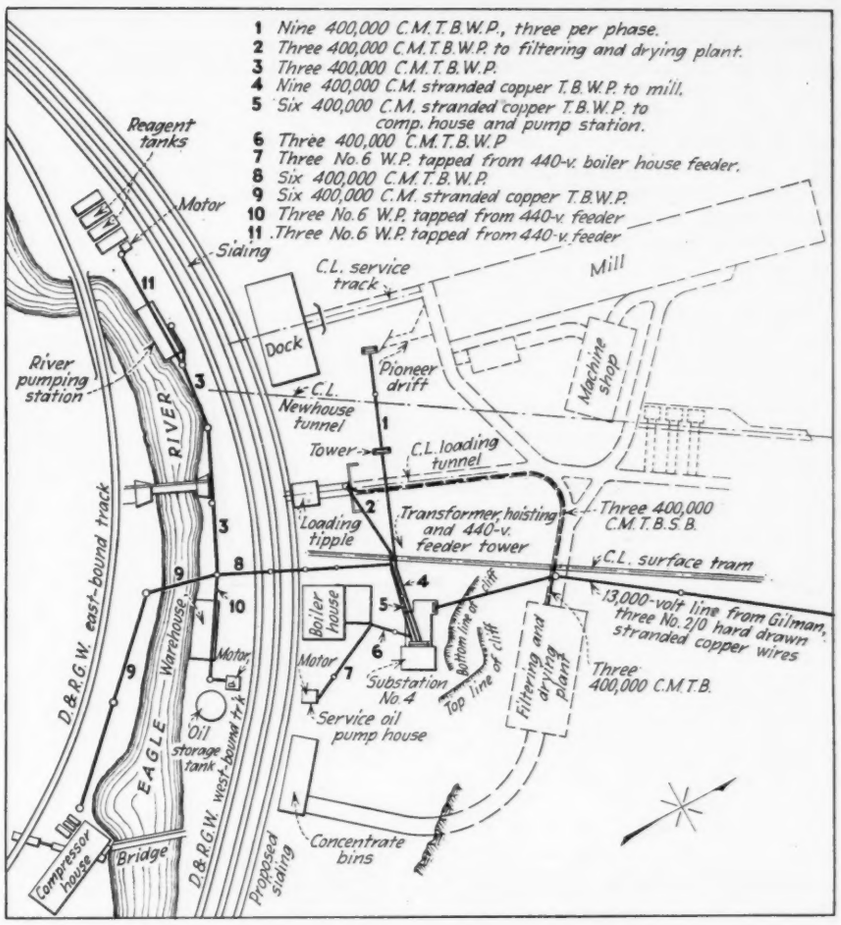
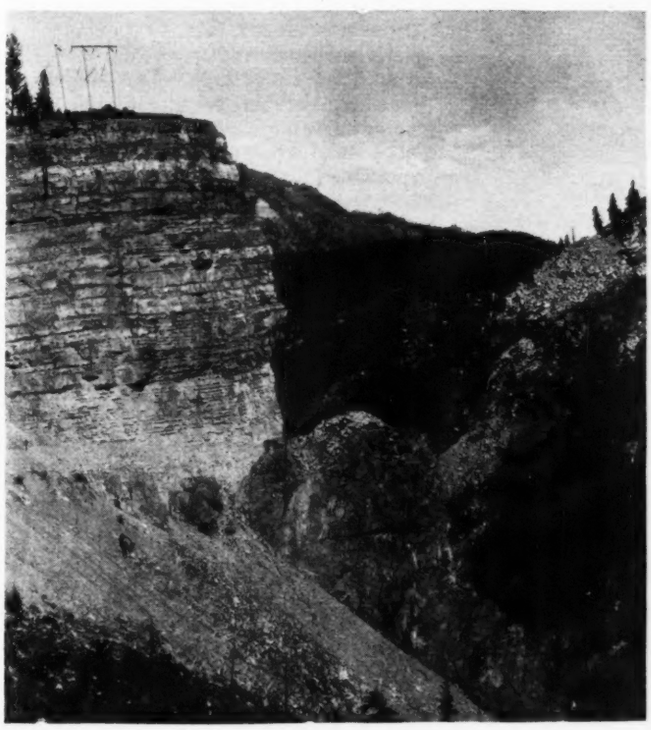

1 Nine 400,000 C.M. T.B.W.P., three per phase.
2 Three 400,000 C.M. T.B.W.P. to filtering and drying plant.
3 Three 400,000 C.M. T.B.W.P.
4 Nine 400,000 C.M. stranded copper T.B.W.P. to mill.
5 Six 400,000 C.M. stranded copper T.B.W.P. to comp. house and pump station.
6 Three 400,000 C.M. T.B.W.P
7 Three No. 6 W.P. tapped from 440-v. boiler house feeder.
8 Six 400,000 C.M. T.B.W.P.
9 Six 400,000 C.M. stranded copper T.B.W.P.
10 Three No. 6 W.P. tapped from 440-v. feeder
11 Three No. 6 W.P. tapped from 440-v. feeder
Reagent tanks
Motor
Siding
C.L. service track
Mill
Dock
Pioneer drift
Machine shop
River pumping station
RIVER
C.L. Newhouse tunnel
Tower
C.L. loading tunnel
Loading tipple
Transformer hoisting and 440-v. feeder tower
Three 400,000 C.M. T.B.S.B.
C.L. surface tram
13,000-volt line from Gilman, three No. 2/0 hard drawn stranded copper wires
Boiler house
Bottom line of cliff
Top line of cliff
Filtering and drying plant
Three 400,000 C.M. T.B.
Motor
Substation No. 4
Service oil pump house
Warehouse
Motor
Oil storage tank
D.&R.G.W. east-bound track
D.&R.G.W. west-bound track
EAGLE
Compressor house
Bridge
Concentrate bins
Proposed siding

**Fig. 2—Electric distribution lines at Belden**

In the switching and metering house the 440-volt bus is supported on a pipe structure, and consists of three 3x¼-in. copper busbars per phase. Three feeder lines are taken from this bus: one line to the mill proper, one to the drying plant and boiler house, and the third to the compressor house and the river pumping station. Each feeder is connected to the bus through a three-pole carbon circuit breaker and disconnecting switches, arranged so that the feeder line can be kept in service while the circuit breaker is cut out for inspection or repair.

The substation switchboard consists of seven slate panels; two transformer



**A 2,037-ft. span in the Leadville-Gilman line**

secondaries, and five feeder panels. These panels have mounted on them one set of disconnecting switches, the carbon circuit breakers, and the metering equipment. Each of the two transformer secondary panels has an indicating ammeter, a recording ammeter, a three-phase ammeter switch, an indicating wattmeter and a watt-hour meter. Three feeder panels have each a recording ammeter and a watt-hour meter. The other two feeder panels are blank, having been installed for possible future use. The situation and general arrangement of the substation are shown in Fig. 2.

All of the electrical power used in operating the underground mill is distributed and used at 440 volts, three phase, 60 cycles. Distribution is made from No. 4 substation, through three main feeders.

The feeder supplying the mill proper consists of nine 400,000-circ.mil, weather-proof, insulated cables, three cables per phase, run overhead on two tower structures to a third structure, at the entrance to the Pioneer drift leading to the new mill. From this tower the cables are run through the Pioneer drift on vertical racks to a switching station built on the upper platform in the southwest corner of the mill stope. Four motor feeder circuits, each protected by a 600-amp., 600-volt, fused safety switch, are run from this switching station to the motor-control stations in the crushing plant, the mill stope, the machine shop, and the compressor room. A three-phase lighting feeder is also taken from this switching station and run to the various lighting-service transformers in the mill. Power consumption in each feeder circuit is measured at the switching station by watt-hour meters.

The filtering and drying plant is fed direct from No. 4 substation by three 400,000-circ.mil weather-proof, insulated cables. Two overhead spans and a run on secondary racks through the loading tunnel take the cables to the service switch in the filtering and drying plant, where the feeder is fused and metered and branched to the motor control stations. The boiler house is fed from three 400,000-circ.mil, weather-proof, insulated cables tapped on the filtering and drying plant feeder at the substation tower.

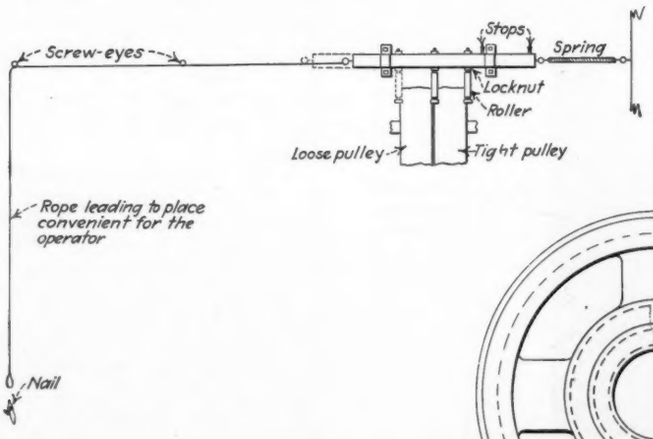
For power supply to the river pumping station and the air compressor house, six 400-000-circ.mil, weather-proof, insulated cables are run overhead from No. 4 substation tower to the compressor house. Three 400,000-circ.mil cables are tapped from this feeder, on the pole on the north bank of the river, and run to the river pumping station, as shown in Fig. 2.

Service over the aforesaid electrical power system, including both transmission and distribution lines, has been eminently satisfactory. Interruptions have been infrequent, and generally they were the result of surges that occur at times during electrical storms.

■ ■ ■

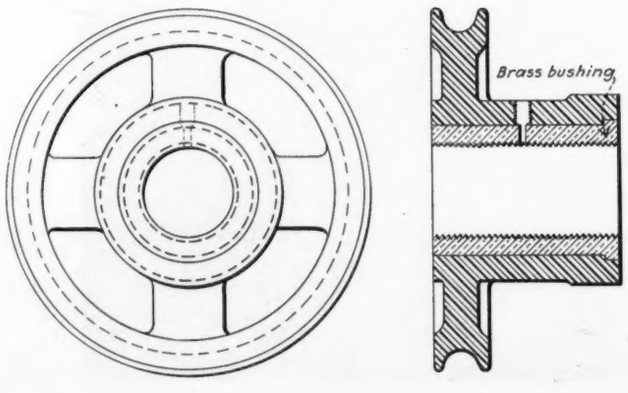
## Simple Belt Shifter Is Safe and Efficient

FREEDOM from injuries to the hands and flexibility in operation are obtained with the belt shifter illustrated —originally designed to control the drive and idler pulley of a belt drive on an ore feeder, writes E. W. Baker, mechanical engineer, Hope Metals Company, Winkelman, Ariz. The device consists of the following parts: Two guide brackets, made of ¼x1-in. strap iron; a 2x2-in. smoothly planed white-pine bar, with a large screw-eye at each end; a screen-door spring; two shifting forks, made of ½x8-in. machine bolts and fitted with short pieces of ½-in. pipe, to serve as rollers and to prevent wear on the edges of the belt; and a length of rope, held and guided by a number of screw-eyes. A 1-in. play between the forks affords ease in shifting the belt, and two sturdy stop screws limit the stroke of the shifting bar. The method of operation is simple: On pulling the rope the belt is shifted from the drive to the idler pulley, stopping the feeder instantly. When released, the tension of the spring returns the bar to its orginial position, at the same time automatically transfering the belt from the idler to the drive pulley. Best results are obtained when placing the shifting arrangement close to the pulleys, with the belt motion toward the shifting forks.




## Brass Bushing Prevents Delay and Expense

FROZEN tension-rod wheels on large crushing rolls, resulting from lack of lubricating facilities and fine dust particles entering the threads of the wheel and rod, caused considerable expense at the crushing plant of the New Cornelia mines of Phelps Dodge, at Ajo, Ariz. Besides loss of crushing time, the frozen wheels, made of cast steel, could not usually be removed from the rods without first being broken up—requiring considerable time because of the tough material—and then replaced by new ones. To avoid this, all wheels were remodeled and fitted with threaded brass bushings and grease cups, as shown in the accompanying illustration.



# New Mine Loader Promises Wide Application

A COMPRESSED-AIR SHOVEL, embracing several new features, has been invented and constructed by J. S. Finlay, superintendent of the North Lily Mining Company, near Eureka, Utah, and E. B. Royle, hoisting engineer. Its use for several months has indicated the following advantages:

1. *Cheapness*—It can be built and sold at a low cost.

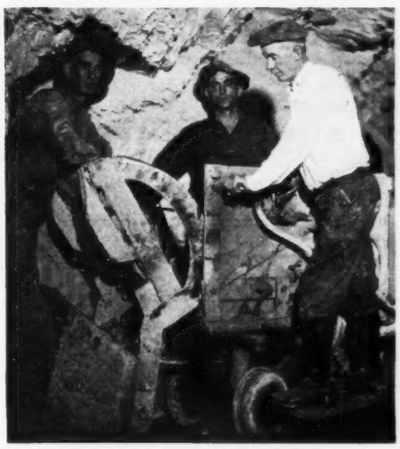
2. *Speed*—Working at an ore pile, where cars are available, the loader will load 150 cars an eight-hour shift. Operating in a drift, where cars are trammed 800 ft. by hand, this loader has loaded 58 cars in a shift, including time out for drilling and blasting, which made a 6½-ft. round drilled and blasted in an eight-hour shift with a crew of two miners, one shovel operator, and two trammers. The operator loaded the cars and trammed them 100 ft. to the nearest station.

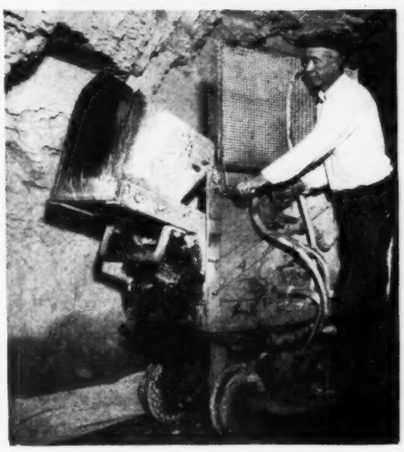
3. *Economy of Space*—The Eimco-Finlay loader can be operated in a 4x7-ft. drift.

4. *Low Cost of Operation and Repairs*—Air pressure is maintained at 90 lb. through a ¾-in. hose. The trial machine operated for over a fortnight, handling 2,000 tons of rock, is without repairs and is still in good condition.

Two novel features are embodied in the construction of the shovel. The valve that controls operations has been modeled after the plan of a "joy-stick" on an airship. Standing on the side of the shovel, the operator has but to twist the valve ahead to run the loader into the ore pile. A lift hoists the loader. A reverse twist of the valve backs the machine, and a push down on the valve lowers the loader.

To provide sufficient traction to push the loader into the pile, the truck is built with heavy, solid, cast wheels and cast spacer blocks weighing over 1,000 lb. Total weight of the machine is about 3,200 lb. It is compactly built, the overall dimensions being such that it will fit into the standard mine cage without the removal of any part excepting air connections and operators' platform. This feature greatly facilitates the rapid and economical transfer of the machine from one level to another and adds materially to its utility. An EE 9 G Ingersoll-Rand air engine is mounted between the driving axles and geared to them by a roller sprocket chain to provide motive power.





**New air shovel in loading, lifting, and dumping positions**

A 28x42⅝-in. steel plate, equipped upon its upper surface with a 24-in. diameter ball race, mounted on the wheel and engine assembly, constitutes the truck, which provides the forward-and-back movement along the track. Mounted on the turntable of the truck is the lifting and dumping assembly, which turns through a limited arc, for operation on each side of the track.

An EE 3 G Ingersoll-Rand air engine, rigged as a hoist, rolls a cam-shaped shovel unit from the digging position to that of dumping. This rolling motion is similar to that of a rocking chair. Side and end slip of the rolling member is prevented by four cables, which allow the loader to roll freely, but hold it straight on its track. A spring bumper is provided at the end of the dumping stroke.

To operate this loader the operator or trammer shoves a car against the machine, to which it automatically hooks. He then moves the valve handle forward, causing the machine to advance and force the lowered shovel into the ore pile. When the shovel will advance no further, the operator raises the valve handle, causing the shovel to rise, providing a combined shoving and raising motion like that of a hand-operated shovel.

The loader filled, the operator stops the advance, elevates the valve handle, and the shovel dumps its contents into the car. The valve handle is now moved down and back, and the machine moves back along the track and the shovel drops down once again to its digging position.

For cleaning up the sides of the drift, the digging assembly is rotated, by hand lever, on the turntable to one side or the other, and advanced into the pile. When dumping from these side positions, the machine automatically straightens itself and unloads into the car. When the car is filled, the coupling hook is disengaged, and the machine "kicks" the loaded car to give it a flying start down the drift.

The Eastern Iron & Metal Company, Inc., Salt Lake City, Utah, has the manufacturing and international sales rights of this machine.

# Among Contributors To This Issue

**R. P. E. Hermsdorf** is a graduate of Columbia University. After three years in the electrolytic department of Raritan Copper Works, he joined the staff of United States Metals Refining, where he has served as assistant metallurgist, technical advisor of casting, superintendent of lead plant, and production superintendent—a position he now holds. **R. Winters,** co-author with Mr. Hermsdorf, has charge of safety, welfare, and plant protection. He was formerly connected with the safety divisions of General Electric, Midvale Steel & Ordnance, New York Shipbuilding, and Youngstown Sheet & Tube.

**E. R. Woodward,** a graduate of McGill University, Montreal, served with the First Canadian Tunneling Company during the War. In the battle of Messines, on June 7, 1917, in company with three brother officers, he exploded one of the most extensive mines of the war, in the preparation of which nine months of labor was involved. For many years he has specialized in lubrication engineering, and is now petroleum chemist in charge of technical work on lubrication and fuels for the Firestone Tire & Rubber Company, Akron, Ohio.

**C. N. Schuette,** a consulting engineer of San Francisco, Calif., is a graduate of the University of California and an authority on the metallurgy of quicksilver ores.

**Dipl. Ing. P. Erimescu** is a graduate in mining engineering of the Bergakademie Freiberg, with an extensive underground and surface experience in the principal Continental mining centers.

**S. D. Strauss,** until recently assistant editor of *Engineering and Mining Journal,* was educated at the College of the City of New York. He has specialized in recent years in economic research of the non-ferrous metals, and has contributed several noteworthy articles on the subject to this publication.

**J. B. Huttl,** until recently assistant editor of *Engineering and Mining Journal,* was educated at the M.A.N. Technical School and the Stadtische Bauschule, Nurnberg, Germany. He obtained operating experience with mining companies in the Ruhr district of Germany, in Spain, Mexico, and Central America, specializing in mechanical engineering and plant maintenance. Mr. and Mrs. Huttl left New York, on a visit to Europe, on April 7.

**Lucien Eaton,** who recently returned to London, where he occupies the position of consulting mining engineer on the staff of Rhodesian Selection Trust, was formerly with the Cleveland-Cliffs Iron Company, for many years as superintendent of the Cliffs Shaft mine, at Ishpeming, Mich.

**R. G. Hall,** who reported on the operation of the Hadsell mill, is a graduate of the Massachusetts Institute of Technology. An extensive metallurgical experience in the United States preceded appointment as resident manager for the Burma Corporation in 1918, where notable technical successes were achieved. Since his return to the United States in 1921 he has practiced as a consultant, with headquarters in San Francisco.

**R. E. Kirkhuff,** a graduate of Ohio Northern University and of the General Electric Test Course, spent five years as designing engineer for the Hartford Electric Light Company. For the past fifteen years he has been a member of the engineering department of the New Jersey Zinc Company, Palmerton, Pa.

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# *Mining Engineering in the United States*

*To the Editor:*

Insidious forces seem to have wrought such changes in recent years that I have difficulty in recognizing mining engineering as a profession, in which brains should be a greater asset than technique or manual skill. Education in certain sciences and arts is essential to success. No calling deserves to be called a profession if its tasks and problems are so simple as to be within the ken of men of ordinary ability and education. An engineer not thoroughly disciplined in science, and alive to its application in industry, cannot qualify as a professional man. He belongs to the rule-of-thumb class, an empiricist.

The mining industry appears to be evolving into large cut-and-dried enterprises. A young engineering graduate, with broad fundamental training, starts as a mucker or general roustabout. If he has an aptitude for engineering, he may become a member of the company staff, with the title of assistant mining engineer, or even mining engineer; but in most cases he is little more than a glorified surveyor. Or he may enter a laboratory, to become an assayer-chemist after many years of drudgery. If he enters the operating branch, he works up to shift boss or assistant foreman. Is this "professional" work? Are not many so-called engineers merely over-educated craftsmen?

The mining organization can be likened to an automobile that causes annoyance and delay by failure of a part, which must be replaced and the new part broken in. Similarly, in the mining industry, an engineer who makes himself valuable to an organization may prove a source of anxiety to his employer. If he breaks down, or changes connections, many difficulties arise. Perhaps this is why large organizations are disinclined to place too much responsibility on any one man. Technical duties are therefore divided among many mediocre positions, the holders of which are readily replaced. This works well for the organization, but does it not tend to destroy initiative, to narrow vision, to stunt technical growth? Does it not lead to a condition of "wheels within wheels," petty rivalries, selfishness?

Many engineers publicly belittle one anothers' work. They seem devoid of the professional pride and ethics so characteristic of the doctor or the lawyer, a pride that regulates professional life, drawing together the members of each group with common aim for their mutual benefit and the elevation of the profession as a whole. We engineers, on the other hand, make little or no effort to stop the activities of the questionable or crooked promoter. We are helpless in the shadow of the self-styled practical engineer, who steals our reputation, writes our reports, and promotes our enterprises, whose only qualifications to the title mining engineer are an engineer's hat, breeches, high boots, and a glib tongue.

Finally, I wonder if the reward of a mediocre "job" is worth the effort and expense involved by spending several years mastering engineering science in a university. Would one not be better off by starting from the bottom without training or a degree? Such positions as surveyor, assayer, draftsman, sampler, shift boss, assistant foreman, and foreman assuredly do not require university training. Could not the technique be learned to better advantage in the years of labor between promotions? ENGINEER.

*Butte, Mont.*

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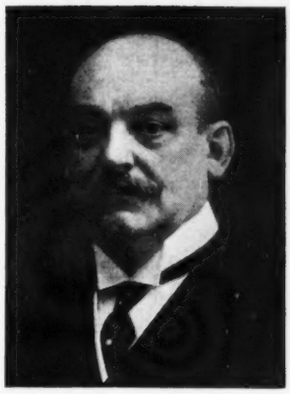
**C. B. Kingston** is in Northern Rhodesia.

**Bernard Beringer** has returned to England from Peru.

**Carl Davis** has returned to London from Northern Rhodesia.

**D. G. Lumsden,** of the staff of Mount Lyell Mining & Railway, is in England.



**Emile Francqui,** has succeeded **Jean Jadot** as chairman of Union Minière du Haut-Katanga.

**F. M. Leland** is now vice-president of American Analyses Association, Inc., of San Francisco.

**Dr. G. J. Mitchell** left New York on March 25 for London, en route to Johannesburg.

**J. Faber Hanst** left New York for Europe on March 28. Mr. Hanst expects to return late in April.

The retirement is announced of **Dr. A. L. Hall,** assistant director of the Geological Survey of South Africa.

**J. E. Hopkins,** assistant manager of Fairbanks Exploration, has returned to Alaska after a visit to Boston.

**E. E. Barker,** manager of Mufulira Copper, Northern Rhodesia, is en route to Europe and the United States.

**E. L. Cochran,** former superintendent of the Ironton mine, Bessemer, Mich., is now residing in Seattle, Wash.

**F. W. Griffin** is in New Guinea, in connection with the initial operation of the Bulolo company's first dredge.

**Carlos W. Van Law,** is visiting New Guinea to advise New Guinea Goldfields as to the development of the property.

**George M. Norman** has been appointed manager of the development department of the Hercules Powder Company, Wilmington, Del.

**F. J. Pirlot** has left the employ of Geomines, which operates tin and coal properties in the Belgian Congo, and is now in Brussels, Belgium.

**C. H. Thurman,** of Oroville, Calif., has resigned as manager of the Cory Mine Company, to devote attention to gold-dredging operations on the Merced River.

**Dr. Alfred Merton,** Chairman of the Board of Metallgesellschaft A.G., Frankfurt a.M., has been elected member of the board of Siemens-Schuckert A.G., Berlin.

**B. Dunstan,** formerly Chief Government Geologist of Queensland, has been investigating the concessions granted to the Commonweath Mines Development, in the Palmer River district of North Queensland.

**Reginald S. H. Richards,** superintendent of the mining department, Mina de Santos Domingos, Mertola, Portugal, is returning to England for a short visit about the middle of April.

**Dr. T. W. Stanton,** United States Geological Survey, is now chief geologist of that bureau. **Dr. John B. Reeside** assumes the post formerly held by Doctor Stanton, in charge of paleontology and stratigraphy.

**A. Gronningsater,** metallurgist of Falconbridge Nickel, has left Toronto for Kristianssand, Norway, where he will spend a few months at the company's refinery there. He expects to return to Canada later in the year.

**Wai Kyi Woo,** formerly superintendent of one of the largest iron mines of the Hoodan district in China, has been made a general in the Chinese army. He is a graduate of the Michigan College of Mining and Technology, class of 1916.

**S. N. Williams,** formerly of Hampden, Cloncurry, and Great Fitzroy mines, has been appointed superintendent and metallurgist of Charters Towers Gold Recoveries, a company formed to treat three million tons of tailing at Charters Towers, Queensland.

**E. G. Leonardon,** general manager of the Société de Prospection Electrique (Schlumberger), now makes his headquarters in Paris. He is at present traveling in the Western United States and expects to address the local section of the A.I.M.E. in Seattle and that of the Canadian Institute in Vancouver, B. C., before returning to Paris.

**Edward Shackell,** managing director of Electrolytic Zinc and a director of Mount Coolon Gold Mines, speaking at the recent annual meeting of the Australian Mines & Metals Association, said: "Although complete returns are not available, the gold output for 1931 will show a substantial increase. It is believed that, concealed beneath superficial drifts and alluvium, Australia has gold-bearing lodes of size and value equal to any hitherto found, and one can only express the hope that the united efforts of the prospector, geologist, and geophysicist, and the enterprise of those who are providing the capital, will be adequately rewarded. The discovery of another Golden Mile would be the best impetus that Australia could receive in these critical times."

**Ernest Maurer,** manager of the Ergasteria Flotation Company, Laurium, Greece, writes in comment of a short article on "Turning Hoisting Sheaves," which appeared in a recent issue. He recalls an experience when master mechanic for the San Francisco Mines of Mexico, operating near Parral, Chih., when the company was faced with a similar problem. "The hoisting cable," he says, "was increased from 1 in. to 1⅛ in. in the cage compartment, but a sheave with groove for 1 in. cable only was on hand. We therefore mounted the sheave with its bearings on wooden horses, and brought the center line of the sheave-wheel shaft in line with a power-driven, pipe-threading machine. A special driving dog was forged, clamped to the end of the sheave-wheel shaft, and fitted into the cutting chamber of the pipe-threading machine, with one inserted die acting as a boss to do the driving."

## Obituary

**Albert Perry Brigham,** professor emeritus of geology at Colgate University; at Washington, D. C., March 31; aged 76. Doctor Brigham founded the Association of American Geographers, and was appointed a consultant in geography to the Library of Congress in 1930.

**J. Claude Jones,** professor of geology, Mackay School of Mines, University of Nevada; at Reno, March 2. Mr. Jones received his doctor's degree in geology at the University of Chicago in 1923. He joined the staff of the Mackay School of Mines in 1909, and at the time of his death was acting dean.

**Abbot Salée,** professor of geology at Louvain University, on March 6, as a result of an automobile accident, at Ruanda-Urundi, Belgian Mandated Territory. Professor Salée had completed a five-year geological survey of the country and of the Kiva district of the Belgian Congo, and was on his way back to Belgium at the time of the accident.

**Florian L. Roots,** mining engineer at the Antomok mine of Benguet Consolidated, in the Baguio district, Philippine Islands, was killed in a fire at the mine late in February. Mr. Roots was directing work for closing in a fire area at the mine when he was overcome. He was a native of Colorado, a graduate of the Colorado School of Mines, and had been employed by Benguet for the last three years.

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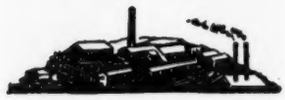
The death of Professor **J. H. L. Vogt,** of Trondhjem, Norway, on Jan. 3, removes from the international field of geology and mineralogy an outstanding figure and from Norway one of her loved and respected citizens. Those of us who enjoyed the privilege of his personal guidance and instruction, and who knew the charm of his refreshing personality, will always hold him in grateful memory. To the profession at large he has become known through his numerous contributions to the technical and scientific press. His most important literary achievement is probably "Die Erz Lagerstätten," written in collaboration with the German scientists Beyschlag and Krusch, and ranking as a clasic in its field. *Engineering and Mining Journal* has been priveleged on several occasions to publish special articles under his signature. In his latest contribution, written less than two years ago, after his retirement from active teaching, he displayed the characteristic youthful interest in the latest developments in the field of geology.

Professor Vogt received his education in Norway, Sweden, Germany, and France. In 1886, at the age of 28, he was appointed professor at the University of Oslo; and in 1912, to the same position at the Institute of Technology, Trondhjem, from which he resigned a few years ago. Membership in a score of European and American scientific academies and societies is a testimony of the esteem in which he was held by his confreres. In 1929 he was awarded the Penrose Medal by American Society of Economic Geologists. He was succeeded at the Institute at the time of his resignation by his oldest son, Thorolf, who, with a younger brother, maintain the high traditions of the Vogt family.

B. H. Strom.





# Dust-Collecting Efficiency Increased in Quicksilver Reduction Plants

C. N. Schuette

WHEN mechanical furnaces such as rotary kilns and hearth roasters are used for reducing quicksilver ores, they must be followed by dust-collecting devices, because the dust, if not eliminated, will choke the condensers in a few hours, or at most in a few days, so that the operation will be brought to a standstill. If dust elimination is better than 95 per cent effective, from the hot gases, the amount of quicksilver in the dust will be so small that the latter can be discarded, and the operation conducted continuously. If, however, the dust collection is less than 95 per cent effective, the operation will be delayed, because the dust will accumulate in the condenser faster than removed by regular clean-up, with the result that capacity of the system is decreased, or time is lost, or, perhaps, both. Moreover, when much dust accumulates in the condenser system, the amount of quicksilver in it is too large to be discarded, and the dust must be dried and treated.

All of the plants with which I am familiar, and which collect the dust by the use of settling chambers and water sprays, electrical precipitation, or cyclones, are compelled to make subsequent use of a retort to treat the dust, for recovering the quicksilver. In many plants I have installed Sirocco collectors, and in every case have found it possible to discard the dust and avoid treatment in retorts, thus cutting the total cost of ore reduction considerably.

As for first cost of dust-collection devices installed, the type mentioned is the cheapest known to me. Compared with its installed cost of $400 to $600, the operator will find that the cost of settling chambers and sprays will run $750 or more as installed, and that collectors of the other type mentioned will range in cost from $1,500 to $15,000, depending on the type and size of the installation. I have thus found the dust collector named to be not only the most efficient type for this particular application but also the one having the lowest first cost.

The operating cost of any type of dust collector used for this purpose is low. If one except the chamber-and-spray system, which incidentally, is inefficient, the power required is that necessary for operating a three to five horsepower motor continuously to run a fan, the cost of this power being about $3 to $5 per day. In the application of electrical precipitation, a similar additional cost will be involved for operating a second motor also.

In new plants where I have installed Siroccos as dust collectors their service has invariably been satisfactory, but the savings to be made by their use are best brought out in re-designed plants, where the costs before and after installation of Siroccos can be compared. In recent years I have re-designed and rebuilt several quicksilver reduction plants using cyclone dust collectors. Some of these plants as originally designed were suited to the ore, and others were not. Suitable preliminary testing makes possible the design of a plant that will give results close to those predicted for any economic grade of ore of the usual type. What such design or re-design can do is shown by data here presented. The figures given are based on 1931 and 1930 operations of the Brewster Consolidated Quicksilver plant at Terlingua, Tex., W. D. Burcham, general manager. The company is the largest producer in this district, and Mr. Burcham is a quicksilver operator of long experience. In 1930 his plant was equipped with a 3x40 ft. kiln, two dust cyclones in series, and Monel condensers. The furnace treated 33 tons per day of ore running 10 lb. quicksilver per ton, and it was down about eight days per month for clean-up. Production may therefore be determined by the following calculation:

$$\frac{33 \times 10 \times 22}{76} \times (0.95 \text{ extraction}) = 91$$

Of this production of 91 flasks of quicksilver, 23 were recovered as free quicksilver, and 68 flasks were, so to speak, in the dust. This dust amounted to about 30,000 lb., assaying about 17.5 per cent quicksilver. This dust had to be retorted.

The cost of operation with this plant was approximately as follows:

| | Per Day |
|---|---|
| Mining, crushing, and sorting.. | $140.00 |
| Development | 20.00 |
| Pumping and power | 20.00 |
| Overhead | 10.00 |
| Treatment plant: | |
| 3 furnace men at $1.75 | 5.25 |
| 2 soot men at $1.50 | 3.00 |
| Fuel, 7 gal. per ton at 10c. gal. | 23.10 |
| 3 retort men at $1.75 | 5.25 |
| 2 cords wood at $10 | 20.00 |
| | $246.60 |

In 1931, the plant was rebuilt, according to my design, a Sirocco replacing the two cyclones, tile pipe replacing the Monel condensers, and an acid-proof exhauster replacing the fan. The plant now runs continuously, and its production is:

$$\frac{33 \times 10 \times 30}{76} \times (0.95 \text{ extraction}) = 124 \text{ flasks free.}$$

Cost of operation with the redesigned plant is about:

| | Per Day |
|---|---|
| Mining crushing and sorting... | $140.00 |
| Development | 20.00 |
| Pumping and power | 20.00 |
| Overhead | 10.00 |
| Treatment plant: | |
| 3 furnace men at $1.75 | 5.25 |
| 1 soot man at $1.50 | 1.50 |
| Fuel | 23.10 |
| | $219.85 |

The total cost being $219.85 per day when producing four flasks per day, the cost per flask was $54.96.

From the costs here given and the rate of production in each case, the saving effected is seen to have been great.

At another plant treating lower-grade ore, and likewise equipped with cyclones that were replaced, the production averaged one flask per day with the former system and three flasks per day with the re-designed plant. The cost at this plant was thus reduced from $155 per flask to about $80 per flask, and has since been brought still lower by cutting costs outside the reduction plant. Likewise, part of the recent increase in production at the Oceanic mine is also due to the substitution of a Sirocco for the cyclones formerly used.

One can see that it is difficult to show in dollars and cents just how great a saving is made by designing a plant on a basis of the high efficiency of the Sirocco collector. The first cost is less, the operating cost is less than some, and certainly not more than any of the others, but perhaps the greatest saving comes from the continuity of operation and increased capacity thus made possible.

The design or re-design by me of several plants based on the possibility of complete dust elimination by using the type of collector named meant the difference between profit and loss at the time. Today most of these plants would be shut down, because of the lowered price of quicksilver, had it not been for the materially lowered costs made possible by this design.

At Mr. Burcham's plant, the old system kept the plant constantly filled with slime, the condensers almost constantly choked, and control of operation impossible. Mr. Burcham's comment on this point is interesting. He says:

"With the installation of the Sirocco and the inexpensive and simple Schuette condensers that can be sluiced out with a fire hose in a few minutes, all confusion was eliminated, with the result that we could study cause and effect and improve furnace operations accordingly. For instance, we found that the economic limit of our furnace is about 27 tons instead of 33 and that 27 tons will actually give more quicksilver than 33 tons of the same grade of ore.

"We are now able to clean up every morning and know the result of our operations of the previous 24 hours. Most of the mercury is free. Each day there is a certain amount of richly laden dust which is dried by the heat of the tube and put back in the furnace that night, thereby increasing the free run of the following day. Therefore each day's clean-up gives us our daily average production as free mercury ready for the flask."

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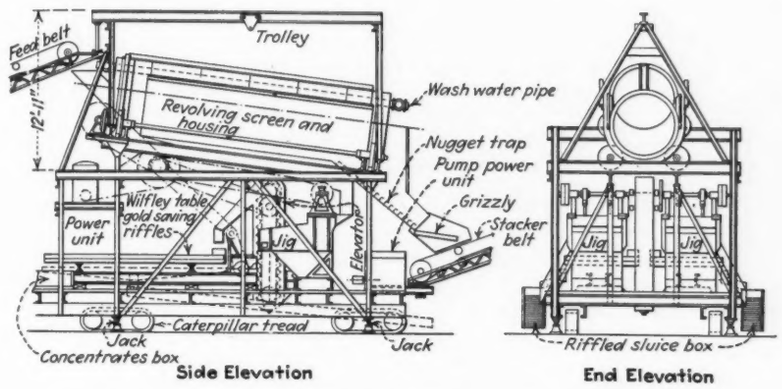
# Portable Concentrating Plant for Gold Placers

## *Other Recently Introduced Equipment*




**Portable concentrating plant for gold placers, capacity 1,500 cu.yd. excavated per 24 hours**

To provide better equipment for recovering gold from placer deposits, The Mine & Smelter Supply Company, of Denver, Colo., has developed a portable concentrating plant for use in places where the water supply may be limited and a moderate investment in equipment is desired. Completely installed, the equipment includes: An excavating shovel, caterpillar tractor type, gasoline or oil driven; a receiving hopper, with apron feeder, for receiving gravel or sand excavated by the shovel and delivering a constant and continuous feed of gravel to the feed belt conveyor; a feed belt conveyor, mounted on a steel frame, to convey gravel from apron feeder to the feed chute of revolving screen at the top of concentrator unit; a concentrator unit mounted on caterpillar treads and including revolving screen, plunger jigs, Wilfley tables equipped with special gold-saving riffles, centrifugal pump, power unit and fittings, all equipment being erected in structural steel frame; gold-saving sluice boxes, with angle-iron riffles, mounted on both sides of the structural steel frame of the concentrator unit; and a stacker belt conveyor, mounted on a steel frame, to convey oversize discharged from revolving screen of concentrator unit to the tailings dump.

The tractor type of shovel is preferred on gold placer deposits containing large boulders or where stripping overburden or vegetation is necessary. If the deposits are near a power line, electric motors may be used. In gravel and sand deposits, where there are no boulders, cable drag scrapers or a dragline bucket may be used. The receiving hopper is mounted on caterpillar treads or car wheels and rails.

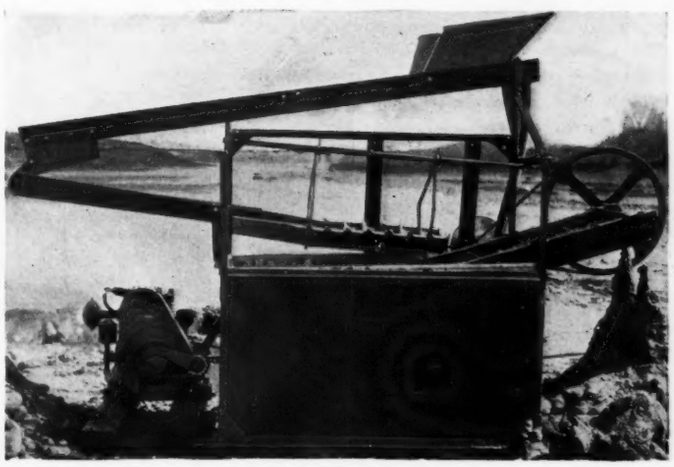
Excavated, the gravel is delivered to the inside of revolving screen in the upper part of concentrator unit. By means of a wash water pipe inside the screen, it is washed while passing through the screen. The feed end of the latter acts as a scrubber to wash gold-bearing gravel, clay, and sand from boulders and pebbles. Succeeding sections of screen are perforated with holes to suit the average size of nuggets or particles. The last section of the screen plates is perforated with rectangular openings, allowing coarse nuggets to pass into the top of the nugget trap. The final oversize falls into the trap some distance below its top and is then discharged by stacker belt conveyor to the tailing pile.

The revolving screen eliminates 50 or 60 per cent of the gravel excavated. Gravel falling through the screen flows to the plunger jigs, which scrub and wash gold-bearing clays and sands from the coarser particles of gravel. As the openings of the jig screen are smaller than those of the revolving screen, any coarse gold nuggets are caught on the former screen.

The jigs eliminate as tailing about 50 per cent of their feed and the concentrate of the hutches is delivered by short continuous bucket elevators to Wilfley tables.

A standard Wilfley table equipped with a novel type of gold-saving riffles is said to combine the high capacity and settling features of riffles used on large gold dredges with features of table riffles and grooves designed to produce an automatic and continuous discharge of gold concentrate. The resultant riffle is said to permit a saving of labor and time compared with stationary riffles and similar devices which require shutting down to clean up the riffles.

The concentrator unit, including revolving screen, jigs, and Wilfley tables, with gold-saving riffles, centrifugal



**Portable placer machine which handles 1 ton of sand per hour**

water pump, power units, and riffled sluice boxes, is mounted on caterpillar treads, so that it can be hauled by the tractor shovel to a desired new location. Portable hydraulic jacks are used to level the unit after moving.

Equipment required for cleaning up concentrate from the unit will vary with the local conditions of the placer deposit, or the character of gold or metal content.

Free gold is retorted and poured into bullion bars for shipment. When gold particles are coated or "rusty," or attached to quartz or gangue particles, the concentrate is ground with charges of mercury in clean-up barrels or ball mills, and the amalgam treated in retorts and converted into bullion bars for shipment. Concentrate recovered in the sluice boxes is cleaned up on the Wilfley tables of the concentrating unit.

Plants of this type have rated capacities of 500 to 2,500 cu.yd. of gravel excavated and treated during each 24 hours, or about 20 to 100 cu.yd. of gravel hourly.

Should the water supply be limited settling ponds may be arranged to receive the tailing and water from the plant and to return 50 to 75 per cent of the water for re-use.

A portable placer machine (known as the G-B), having a capacity of 1 ton of minus-¼-in. sand per hour, has also been developed by the same company. It combines a water tank, a water supply pump, a grizzly, shaking riffles, and a tailing conveyor. Its weight is 140 lb. and with gasoline motor 230 lb. Knocked down for transport the machine can be placed inside the water tank, which is 34½ in. long, 15¾ in. wide, and 21 in. high, or small enough to go on the rear seat of an auto.

Water recovery is one of the major features of the machine. During operation, the water is pumped from the tank to the upper launder and washes the sand down to the grizzly bars. The oversize is eliminated and the fines carrying the values pass the bars to the lower launder. The latter discharges into the shaking riffle, the action of which keeps the bed of sand in a mobile state permitting the sand to be washed away while the heavy minerals are trapped behind the riffles. Sand from the riffles is dragged up an inclined plate by the tailing conveyor, and any excess water drains back into the tank for recirculation.

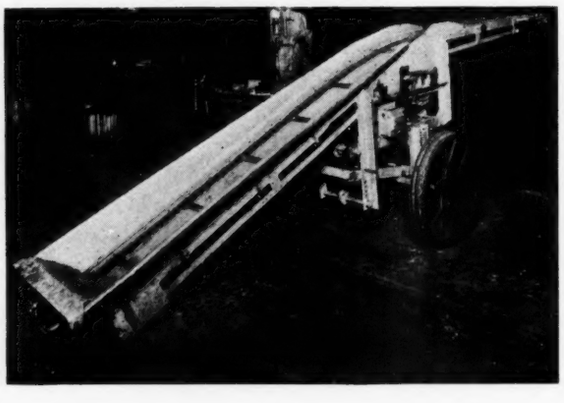
The shaking riffle is swung on two cradle arms to permit an easy and quick clean-up. Thirty seconds to one minute is sufficient to clean up. Gasoline consumption is approximately one gallon per eight hours.

### New Process Chrome Brick Superior Under Test

Improvement of its process of making chrome brick has yielded a brick which E. J. Lavino & Company claim has the advantages of less spalling and cracking, greater resistance to penetration of destructive elements, higher hot-load strength, much greater resistance to abrasion and erosion, and a sagging point 300 deg. F. above that of any other chrome brick heretofore produced commercially. These brick are said to be better in appearance and of denser structure and greater strength than any other heretofore made. Tests showed that the new brick have an average spalling loss of 3.5 per cent, compared with 15.9 per cent for brick made by the usual process. This has been achieved by producing a raw material which will break down into the proper shaped grains and by so controlling the grain size ratio as to produce a homogeneous structure and at the same time eliminate internal strains which cause spalling. Tested hot under a load of 25 lb. per square inch, they were held at 2,500 deg. F. for three hours without failing, at the end of this period showing only slight signs of sagging. In the test made expressly to determine their resistance to sagging, no sagging started until 2,790 deg. F. was reached. In this test, a 9-in. straight brick is laid flat in a pier with each end projecting 2¼ in., and the furnace temperature is raised from that of the room to 2,800 deg. F. at a rate of 100 deg. per hour. The brick are held at 2,800 deg. F. for two hours.

### Portable Conveyor of Aluminum Alloys

An accompanying cut shows a portable conveyor designed for mine service by Duncan Foundry & Machine Works, Inc., Alton, Ill. Save for the chain and flights, wheels, motor and certain minor parts, which are of steel, the conveyor is made of light, strong aluminum alloys. Total weight is 980 lb., 41 per cent less than a steel conveyor of similar size and capacity.



**The weight of this portable conveyor has been decreased 41 per cent by the use of aluminum alloys**

### Iron Particles in Scrap Revealed

Automatic detection of iron particles in briquets or cabbages of brass and copper scrap is possible by use of a magnetic device perfected by Dings Magnetic Separator Company, Milwaukee, Wis. This detector is designed for use by smelters and refiners to assure freedom from iron in certain scrap metals. The principle involved is that of magnetizing the particle of iron first and then passing it through a secondary field wherein it induces an electrical circuit which is registered on a galvanometer. The higher magnetic sensitivity of iron as compared with other metals is utilized to make its detection possible. The machine is said to have readily detected single pieces of iron weighing only a gram inside an 8x8x24-in. brass-wire briquet.

### Acid Pump Design Modified

The so-called Olivite pump for handling acids and corrosive solutions is now made in modified design by its manufacturers, Oliver United Filters, Inc. The design provides for circulating water or clear solution on the packing gland in place of grease, if grease is not desired. Means of adjusting packing and packing glands have been simplified. The pump shaft is anchored to the impeller by a longitudinal tie-rod extending through its axis. Attachment of sleeve to shaft is more substantial than ever. Roller bearings on the shaft have ample oil-chamber lubrication.

### A Mining Engineer's Valve

A valve designed and perfected by P. K. Saunders, a mining engineer in South Africa, has been taken over by the Hills-McCanna Company, 2349 Nelson St., Chicago. It was originally intended to eliminate leaks in water and air lines that cause much unnecessary expense. It has no metal to metal seats and neither stem packing nor stuffing boxes. Air, water, or other fluid handled never reaches the valve bonnet. A flexible diaphragm which, in the closed position of the valve, is compressed between the compressor follower and the seat, protects all working parts from the substances handled. The diaphragm is flexible, rising from the seat as the follower is screwed up. Even distribution of pressure on the diaphragm is secured through proper design and machining of the seat and the compressor follower.

### Excavators Increasingly Welded

To secure the obvious advantages, Demag A. G., of Duisburg, Germany, have almost completely discarded the use of riveted connections in building new models of excavating machinery and are employing electrically welded connections instead. Riveting has been

retained solely for parts which are subject to great wear and tear and therefore require renewal. On the company's Type U 21 excavator only 80 rivets are used.

#### Locks Bucket Pins

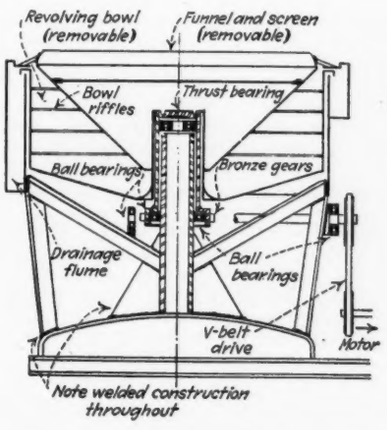
An improved method of securing the pins of dredge buckets is provided in the so-called Kent bucket-pin locking device, according to the sponsors, Hadfields Limited, Sheffield, England. This device, the makers claim, prevents all movements of the pin and is so designed that the pull of the adjacent bucket tends to wedge the head of the pin tighter.

#### Dresses Rock Drill Striking Faces

A tool for facing the striking ends of drill-steel shanks, rock-drill pistons, and anvil blocks has been introduced by Ingersoll-Rand Company, New York. It is known as the 4K shank grinder. It consists of a "Multi-Vane" air grinder mounted in a frame to allow the grinding wheel to be moved back and forth by means of a handle. The wheel is fed against the face being ground by a spring tension device. In its center is a counter-sinking bit for removing the burr from the hole in hollow-drill steel.

#### For Amalgamating Gold Ores

Another machine for effecting the amalgamation of gold ores by utilizing centrifugal forces has been developed by Welded Products Company, 2900 Cecelia St., Bell, Los Angeles, Calif. This amalgamator is known as the "Fabriform," and is said to be able to recover not only free gold and other free metals from placer and mill-run ores, but also any gold which ordinarily cannot be saved except by forced amalgamation. The standard bowl is 24 in. in diameter and has a capacity of approximately 40 tons a day. Its essential features are shown in the accompanying line drawing. Amalgamation is controlled for various types of ores by adjusting the bowl speed. The claim is made that no mercury is lost in operation. The ore is fed into the center of the bowl mixed with sufficient water to separate all particles and permit material of high specific gravity to be thrown in contact with the mercury. Gold hard to amalgamate is retained in the riffles because of its specific gravity. The mercury forms a vertical wall in the lower riffles. The machine is of fabricated steel and of welded construction, and is equipped with anti-friction bearings. Bowl and riffles are dynamically balanced. The total weight is 400 lb.




#### Safe Circuit-Breaker for Universal Use

For circuit protection wherever electric power is used a safe, flashless device known as the A B "De-ion" circuit breaker has been developed by Westinghouse to perform the function heretofore left to carbon circuit breakers or fuses. This breaker has no parts requiring to be replaced and can be reclosed as easily as a switch. Among other advantages, its rating cannot be changed by unauthorized persons.

#### For Pulverizing Prior to Sampling

Where coal must be pulverized previous to analyzing it, the improved disk pulverizer introduced by the Iler Company, Cleveland, Ohio, will be found of use. Both pulverizer and motor are mounted on a single base. Models for operation from line shafts are also available. Main bearings and guides are lubricated by a pump. The pulverizer may be had in two sizes.

■

## INDUSTRIAL NOTES

Allis-Chalmers Manufacturing Company announces that the suit between it and the Dayton Rubber Manufacturing Company, of Dayton, Ohio, involving patent infringement of Allis-Chalmers Geist patent No. 1,662,511, pertaining to multiple "V" belt drives, has been settled out of court. The Dayton company takes a license under the Geist patent and Allis-Chalmers has the right to operate under the Short patent No. 1,538,303, if it so desires.

Incorporation of the so-called Institute of Photogrammetry Inc., a patent-holding company in the aërial photographic mapping field, has been announced by Norman H. Brock, president of Brock & Weymouth, Inc. The new company has acquired numerous patents relating to aërial photography, including Patent No. 1,331,978, which was the basis of the infringement suit brought by Brock & Weymouth against Fairchild Aviation Corporation and its subsidiaries. After two years of litigation, the Fairchild Corporation is reported to have agreed to pay royalties and settle the claims arising from past use of this patent. Brock & Weymouth, Inc., and Fairchild Aërial Surveys, Inc., have taken licenses under all the patents owned and controlled by the Institute, and negotiations are being conducted for licensing others.

## Bulletins

**Screens**—Hadfields, Ltd., East Hecla and Hecla Works, Sheffield, England. Bulletin No. 328, revolving screens.

**Dust Collecting**—The Northern Blower Co., West 65th St., south of Denison, Cleveland, Ohio. Bulletin No. 500-1, dust filters.

**Gas Producers**—Semet-Solvay Engineering Corporation, 40 Rector St., N. Y. City. Bulletin No. 45, Koller type gas producers.

**Industrial Cars**—The Atlas Car & Manufacturing Co., Cleveland, Ohio. Bulletin No. 1240, industrial car equipment.

**Refractories**—The Denver-Fire Clay Co., P. O. Box 1107, Denver, Colo. Catalog No. 145-B, standard refractory specialties.

**Mine Locomotives**—The Ruth Company, Denver, Colo. Bulletin describing and illustrating the company's gasoline locomotives.

**Quarry and Open-Pit Machinery** — Smith Engineering Works, Milwaukee, Wis. Telsmith Bulletin 266H, on "Mining, Quarry and Pit Machinery."

**Clamshell Buckets** — Wellman Engineering Co., Cleveland, Ohio. A folder on the Williams "Champion Cleanup-Rehandler" clamshell bucket.

**Pumps, Dredges**—Morris Machine Works, Baldwinsville, N. Y. Bulletins Nos, 140, 141, 142 and 143, on pumps, dredges, and pumping plants for sand and gravel production.

**Conveying** — The Diamond Rubber Co., Inc., Akron, Ohio. Bulletin "How Shall We Handle It?" detailing various applications of the belt conveyor in 27 different industries.

**Refractories**—The Denver Fire Clay Co., Denver, Colo. Catalog 145, containing 71 pages of illustrations and descriptions of refractories of varied industrial and special uses.

**Chrome Cement**—E. J. Lavino & Co., Philadelphia, Pa., Bulletin 1-21-1, Applications for "Wetchrome," a ready-mixed cement for laying refractory brick in furnaces of all kinds.

**Mine Ventilation.** Westfalia-Dinnendahl-Gröppel A.G., Bochum, Germany. Tables (German text) for rapid determination of principal quantities involved in computing for mine ventilation installations

**Transport**—Easton Car & Construction Co., Easton, Pa. Bulletins No. 3-B, rocker-dump quarry car; No. 42, Granby quarry car; No. 28-A, Phoenix quarry car; No. 41-A, WonWay quarry car and No. 40, Easton quarry truck body.

**Pulverizers**—Raymond Bros. Impact Pulverizer Co., 1302 North Branch St., Chicago, Ill. Catalog detailing the special applicabilities of the company's mills, pulverizers, air separators, dust collectors, exhausters, and automatic feeders.

# NEWS OF THE INDUSTRY

## UNITED STATES

*San Francisco, Calif., March 30*

**Beebe to Build New Mills.** Alex Wise is reported to have announced that a 300-ton mill will be constructed at the Beebe gold mine near Georgetown, Calif. Recently, a 24-ft. Hadsel mill was erected and tried out. The new plant will be equipped for leaching with cyanide solutions. Fred Wise is to be general superintendent of Beebe Gold Mining.

**Kennedy to Deepen Workings.** Kennedy Mining & Milling, of Jackson, Calif., is preparing to sink to its next lower level. The present lowest level is the 4,950 and the new level will be at 5,100 ft. A new underground hoist for the property is being constructed at Knights' Foundry, Sutter Creek.

**Oceanic Raises Output.** The Oceanic quicksilver mine, in San Luis Obispo County, is being operated by the Consolidated Metals and is producing from 65 to 70 tons of ore per day. Quicksilver recovery is about 170 flasks monthly. The orebody is now being mined by top-slicing. Raises are extended to the top of the ore and an 8½-ft. slice is mined over the full area of the ore. On completion, the timber props are blasted down upon a flooring of planks and stringers when the succeeding slice is attacked.

**Bulolo Dredge Starts Operation.** The first gold dredge erected by the Bulolo Gold Dredging, Ltd., at its property in New Guinea was placed in operation on March 21, 1932, and cablegrams state that both dredge and power plant are operating satisfactorily. The dredge has dug out of its pit and the first cleanup is scheduled for the fourth of April this year. As will be recalled by readers of this publication, the materials and equipment for the dredge and power plant were carried by airplanes from the seaboard to the site of dredge erection.

**Bunker Hill Crosscutting.** A crosscut is being driven to the orebodies on the No. 21 level of the Bunker Hill & Sullivan mine, near Kellogg, Idaho, according to Stanly Easton, vice-president of the company. The No. 21 level is opened through a winze-shaft from the No. 19 level and is 2,400 ft. below the Kellogg tunnel, the main working outlet in the mine. Ore reserves at the property were 2,418,784 tons on Dec. 31, 1931, which is a drop of about 60,000 tons from the reserves at the end of the previous year. No particular reference is made to the new orebody developed in the upper levels two years ago. The balance sheet shows the company advanced about $200,000 in additional funds to exploration and mining companies in which it has an interest.

*Salt Lake City, Utah, March 27*

**Magma Opening at Depth.** Magma Copper's development work during 1931 consisted largely of exploration of the lower levels through its No. 5 shaft, which is down below the 3,200 level at the property in the Superior district of Arizona. On this level, the rock temperature is 126 deg. F. and the No. 5 shaft will be connected with the Nos. 2 and 3 before extensive opening of the vein is possible. On the 2,800 level, no ore has been opened west of No. 5 shaft. In the east section of the mine at this depth, a length of 320 ft. of low-grade ore has been opened. Sinking of the No. 7 shaft to 2,550 ft. has been completed and the No. 6 shaft was down to 2,316 ft. at the end of 1931.

**Utah Smelters Curtail.** Scale of operations has been reduced at the Tooele plant of International Smelting. The copper smelter was shut down as a result of the suspension of shipments from the Walker mine, Plumas County, Calif., on March 1. The lead smelter is being run on a one-furnace basis eighteen to twenty days a month and operation of the oxide mill has been cut to ten to twelve days a month.

Operations were suspended at the Murray smelter of the American Smelting & Refining Company on March 9 for a 60-day period in order to accumulate sufficient ore to warrant a resumption. Operations at the Garfield smelter have not been affected. About 200 men were affected by the order. The plant had been in continuous operation since Oct. 1.

**Utah Copper,** by rotating employment, has kept on 70 per cent more men than present plant conditions require, without increased costs or impaired efficiency. The original plan was to divide the available full-time work by the number of men and make an even division of hours among the entire working force of 2,200. For example, if 33 men were to be employed where only 17 were necessary, each man would work 17 shifts each 33 days. Special consideration is being given to employees on low wage scales in order that their reduced earnings will not fall below the minimum standard of living. At present mechanics and others in the high-paid brackets are working about 15 days per month, the number of days per man being graduated upward as the pay rate decreases, the lower brackets receiving about 22 days per month. Extra time also is given to those with several dependents or with urgent family needs. No fixed rule is applied in determining hours on the basis of need, but each case is decided on its individual merit. To meet a seasonal increase in operations it was decided to take on additional employees rather than to increase the working time of those already employed, thus improving general conditions in the community. The company states that "This plan involves extra office detail but does not necessarily entail additional expense. Neither does it appear to decrease the efficiency of the organization. Even if there should be a slight increased expense or lower efficiency or increased accident exposure, the fact that 70 per cent more men are being employed and a corresponding per cent more families are being helped through these trying times of unemployment than would otherwise be the case, makes it well worth while and fully justifies the additional expense and trouble." Other case studies of work-spreading are cited in a report recently issued by the President's Organization on Unemployment Relief.

*Wallace, Idaho, March 25*

**Hecla Limits Development.** Development work done in the Hecla mine, in the Coeur d'Alene district, Idaho, was limited during 1931, with the result that ore reserves declined to 1,806,578 tons, or nearly 200,000 tons from the reserve at the end of the previous year.

**Jack Waite Suspends.** Heavy snowfalls, which made shipments of ore and concentrate from the property impossible, have necessitated suspension of operations at the Jack Waite mine, in the eastern section of the Coeur d'Alene mining district, Idaho. Production at the mine had been greatly curtailed recently, only 40 men being employed.

*Butte, Mont., March 31*

**Anselmo and Badger State Close.** The following notice has been posted at the Anselmo and Badger state mines of the Anaconda company: "Operations at this mine will be temporarily suspended with the night shift of today. Owing to the falling off of the world's consumption of copper, with the resultant decline in price and the increasing accumulation of excess stocks of metal, this action, though regrettable, is necessary." Both of these mines have been large producers, but remaining mining operations of the company on Butte Hill will give employment, on approximately half time, to between 3,500 and 4,000, and Butte mines are maintaining their full share of production in proportion to other Anaconda properties. Probably commensurate reductions in operations will be made at the company's smelters at Great Falls and Anaconda.

**Airplane Reprovisions Camp.** Vosburg Syndicate, operating the Vosburg mine, in the Winston district, reported during the middle of March that its men were marooned by snow, and an airship was chartered by Clinton M. Roos, manager, to carry food and drop it at the camp. "Red" Morrison piloted the plane and from a distance of 300 ft. dropped

three packages of 50 lb. each, within a radius of 20 ft. The syndicate is operating a silver-lead-gold deposit adjoining the Kleinschmidt property of the Montana Mines Corporation. John Roos is superintendent.

**Big Belt Gold Producing.** Big Belt Gold Mining, after many months of development, is producing placer gold from its workings in Magpie Gulch, Canyon Ferry district, near Helena.

**York Mine Drilling Placers.** York Mines Corporation has been drilling placer deposits in the vicinity of the old camp of York, near Helena, and is reported to have proved more than 3,000,000 yd. of gravel.

**Strawberry Mines Completes Mill.** Ben H. Jackson, head of the Strawberry Mines Syndicate, near Pony, reports the completion of a ten-stamp mill.

*Miami, Ariz., March 26*

**Copper Curtailment in Arizona.** Curtailment of output at Arizona copper mines continues. At Miami, the Miami Copper mine and mill were idle for ten days from March 11 to March 21, and a similar shutdown is expected for April. The adjoining Van Dyke mine was closed down indefinitely, on March 26. Curtailment at Inspiration will cause the laying off of 125 men there on April 1. The New Cornelia branch of the Phelps Dodge Corporation will suspend production as soon as the April tonnage quota has been mined about April 24.

**Katherine Gold Unwatered.** Unwatering has been started at the Katherine gold mine, 30 miles west of Kingman, which was recently taken over by the Katherine Group Syndicate. A Worthington Diesel engine has been purchased from the McCracken mine, near Signal, and is furnishing power to run the pumps. Edward K. Thornton, of Los Angeles, is trustee for the syndicate and Ray Dimmick has charge of the mine.

**U.V.X. Working Davis Group.** The Davis group of claims, in the Santa Claus basin, 35 miles south of Salome, is being developed by United Verde Extension, which has set aside $30,000 for the purpose. Chester Hoatson, formerly a director of Calumet & Arizona, is in charge of the work.

Four miles from the Davis claims the Anozira Mining company has been operating the Sheep Tanks mine for the past year. A 1,300-ft. tunnel and several crosscuts and raises have been driven. Milling grade gold ore has been blocked out and the company is considering erection of a mill. The company is a closed corporation, of which J. B. Pitblado, of Los Angeles, is president.

**Copper Companies Win Suits.** Early in March Magma and United Verde Extension won suits in the Arizona Superior Court that they had brought to have their tax assessments for 1930 and 1931 reduced. The courts ordered substantial refunds to both companies. The numerous tax suits which have been won in recent months by Arizona mining companies have been a serious blow to state and county treasuries, which had already been hard hit by the decline in the copper mining and other industries.

*Houston, Tex., March 3*

**Earth Products Formed.** On Feb. 12 a new company, Earth Products, was formed at Houston, Tex., with a capital of $300,000. The company will handle various non-metallic minerals, storing them in a 75x300-ft. all-metal building at Houston. The plant will be divided into three divisions: one for bleaching earths, with a daily capacity of 300 tons; one for stucco, plaster, high-temperature refractories, asbestos, molding sand, silica flour, volcanic ash, talc, calcium carbonate, barite, kaolin, and natural color sands and aggregates; and the third for custom grinding of non-metallic commodities to customers' specifications. Ample storage space is being provided. W. W. Rodgers is president of the company and P. M. Fitzhugh is chief engineer.

*Hibbing, Minn., March 25*

**Mesabi Mines Closing.** Considerable activity was observed on the Mesabi range during March, but it was of the type more pleasing to the bear than the bull element; more mines were closing down. The Morton mine, west of Hibbing, has been turned back to the fee owners after being held by Inland Steel for several years. All the location houses were sold and moved away, and nothing is left at the property but a steel headframe and a brick power house. The Sargeant mine, west of Keewatin, owned by International Harvester, shut down during March and will not open for the remainder of the year. This is an underground property employing about 125 men. The Bruce mine, near Chisholm, also owned by International, closed down in March, will no expectation of opening this year.

Pumps are being removed at the Alexandria mine, between Hibbing and Chisholm. This property, belonging to Republic Steel, closed down last August. It has a stockpile of ore sufficient to supply all needs for this year. Near Marble, the Hill-Trumbull mine, operating an open pit and washer, has canceled its power contracts, which means no operation for 1932. At Taconite, the Holman Cliffs mine, also operating an open pit and washing plant, removed its pumps during March, flooding the pit.

At Hibbing a hot controversy is now on between Oliver Iron Mining and residents of North Hibbing regarding the closing of the west road leading

## Annual Reports of Mining Company Earnings, 1931

| Company | Product | Location | Operating Profit | Net Profit | Net Profit Previous Year | Value Output | Dividends |
|---|---|---|---|---|---|---|---|
| Alaska Juneau | Gold | Alaska | $1,484,891 | $1,070,391 | $831,086 | $3,879,839 | $584,950 |
| American Zinc | Zinc, sulphuric acid | Various | $513,035 | $212,446 | $190,623 | $5,338,891*a* | None |
| American Smelting | Various | Various | $9,278,957 | $874,976 | $11,098,751 | *b* | $8,359,927 |
| Balatoc Mining | Gold | Philippines | $845,768 | $642,732 | $523,275 | $1,407,335 | $625,000 |
| Benguet Cons | Gold | Philippines | $1,192,835 | $1,043,812 | $1,062,242 | $1,666,175 | $850,000 |
| Bunker Hill & Sullivan | Lead, silver | Idaho | $532,200 | $100,589 | $1,529,338 | $4,587,235 | $553,246 |
| Callahan Zinc-Lead | Lead, zinc | Idaho | —$57,249 | —$61,130 | —$65,910 | $4,140 | None |
| Calumet & Hecla | Copper | Michigan | —$623,036 | —$2,573,399 | —$6,749 | $5,965,533 | None |
| Crown Mines | Gold | South Africa | *b* | £1,108,620 | £1,051,072 | £4,193,349 | £660,143 |
| Federal M. & S | Lead, zinc | Idaho | —$32,307 | —$135,507 | $951,623 | $3,007,304 | $104,563 |
| Geldenhuis Deep | Gold | South Africa | *b* | £76,527 | £65,516 | £845,069 | £56,667 |
| Gopeng Consolidated *c* | Tin | F.M.S | £34,254 | £27,733 | £50,815 | £49,294 | £26,384 |
| Hecla Mining | Lead, silver | Idaho | $547,609 | $521,833 | $1,077,226 | $1,425,266*a* | $400,000 |
| Homestake Mining | Gold | South Dakota | $4,193,981 | $2,436,599 | $1,492,871 | $8,935,307 | $2,122,302 |
| Hudson Bay Mining | Gold, silver, copper, zinc | Manitoba | $4,847,569 | —$301,947 | $2,916 | $4,589,060 | None |
| International Nickel | Nickel, copper | Canada | $10,556,001 | $5,094,497 | $11,770,060 | *b* | $8,494,906 |
| Iron Cap Copper | Copper | Arizona | —$126,038 | —$141,371 | —$66,612 | $158,976*a* | $4,654 |
| Isle Royale | Copper | Michigan | —$255,571 | —$378,993 | —$343,667 | $457,465*a* | None |
| Kirkland Lake Gold | Gold | Canada | *b* | $203,051 | $74,490 | $586,251 | None |
| Magma Copper | Copper | Arizona | $237,953 | $206,225 | $1,019,991 | $2,689,331*a* | $459,174 |
| Minerals Separation | Holding | England | *b* | £33,948 | £54,658 | £58,039*d* | £10,000 |
| Mining Corporation | Cobalt, silver | Canada | $458,421 | $347,100 | $91,322 | $596,690*a* | None |
| Modder B | Gold | South Africa | *b* | £449,464 | £575,315 | £1,128,738 | £420,000 |
| Newmont Mining | Holding | Various | $830,067 | —$206,709 | $2,332,770 | *b* | $531,646 |
| Noranda Mines | Gold, copper | Canada | $4,462,556 | $2,374,041 | $3,842,115 | $10,743,863 | $1,119,886 |
| Old Dominion | Copper | Arizona | —$282,916 | —$620,935 | —$887,824 | $629,569*a* | None |
| Park Utah | Lead, zinc | Utah | —$382,068 | —$473,400 | —$142,285 | $309,804*a* | None |
| Patino Mines | Tin | Bolivia | £313,351 | —£87,305 | —£158,004 | £1,102,776 | None |
| Petaling Tin *c* | Tin | F. M. S | *b* | £29,443 | *b* | £102,500 | £29,166 |
| Phelps Dodge *e* | Copper | Arizona | $983,903 | —$983,903 | $515,173 | $50,318,986*a* | $2,131,421 |
| Premier Gold | Gold, silver | Canada | $842,507 | $340,542 | $388,071 | $1,648,350*a* | $635,713 |
| Rose Deep | Gold | South Africa | *b* | £30,372 | £48,938 | £650,495 | £16,575 |
| Sherritt Gordon | Copper, gold, silver | Manitoba | $284,879 | $275,509 | ..... | *b* | None |
| Tintic Standard | Lead, silver, gold | Utah | 1,105,157 | $359,922 | $796,055 | $3,055,716 | $461,326 |
| U. S. S. R. & M | Holding | Various | $4,763,759 | $2,504,759 | $3,699,656 | *b* | None |

In general, the figures for operating profit (or loss) represent the balance after deducting cash expenditures from the value of production. The figures for net profit (or loss) include the addition of sundry income, and the deduction of charges for depreciation, taxes, or other extraordinary expenditures. Because of the difference in accounting methods of different countries and different companies, the figures are not strictly comparable.

All reports for calendar years ending Dec. 31, 1930 and 1931, unless otherwise indicated.

*a* Gross receipts from sale of ore, concentrate, or metal.
*b* Not available.
*c* Years ending Sept. 30, 1930 and 1931.
*d* Royalties.
*e* Includes Calumet & Arizona income for last three months of 1931.

through the Penobscot location. If the village council does not consent to closing the road the Hull Rust mine stripping operation will shut down and throw out of work the heads of approximately 520 families. These men are working either full or part time.

**Ore Shipments in 1932.** The outlook for iron ore mining for next season is gloomy. The most optimistic estimate of ore shipped from the Lake Superior district for 1932 does not exceed 15,000,000 tons, and most operators feel shipments will be closer to 12,000,000 tons. Families of employees went through a hard winter during 1931-32, as most underground mines worked only two days a week, giving the men an average wage of less than $50 per month per family. Next winter is not expected to be as good as the one just completed. The municipalities of the various mining towns are relieving the unemployment situation with what tax money can be spared, but if the mines do not work at least part time this assistance is not sufficient. The only help for the situation is increased steel consumption at the Lower Lake Ports.

*Reno, Nev., March 25*

**Nevada Con. Not to Close.** Col. D. C. Jackling, president of Nevada Consolidated Copper, while in Nevada last week stated emphatically that closing down of the Nevada operations at Ely is not contemplated. He admitted that further curtailment of output might have to be undertaken, but said it would not be drastic. He stated that he could not give definite figures or even predict the amount of reduced tonnage output contemplated until he had attended the director's meeting of Kennecott Copper in New York City. He was on his way to the meeting when interviewed.

**Bradshaw Resumes.** Bradshaw, Inc., has started shipping gold precipitates to the Selby smelter. Work was started on the season's run treating the tailings of the Goldfield Consolidated at Goldfield on March 6, and on March 16 about $12,000 was shipped. Predictions are that a like amount will go out April 2. The plant was built in 1927, and has paid twelve dividends of $10,000 each, a total of $120,000. Mark Bradshaw predicts that the output this season will be greater than that of any other so far. He is employing 23 men at the plant.

*Boston, Mass., March 22*

**Calumet & Hecla Development.** Work in the Calumet & Hecla properties during 1931 resulted in opening considerable new stoping ground in the Kearsarge lode, the annual report of the company, largest copper producer in Michigan, indicates.

**Christmas Finds Ore.** The disclosure of a new series of ore beds, averaging 3.18 per cent copper, is the most important development in the history of Christmas Copper, operating at Christmas, Ariz., according to F. P. Knight, president of Iron Cap, which controls Christmas.

**Mascot Work Reduced.** Production at the Mascot zinc mine, in eastern Tennessee, has been reduced because of decreased demand for the high-grade zinc concentrate, H. I. Young, president of American Zinc, Lead & Smelting, states in the annual report. Ore reserves dropped by a tonnage approximating that mined in 1931. Development is being confined to underground drifting on proved orebodies. Some drilling is being done on outside properties that can be brought into production when demand justifies. The company has sold its Big Chief mine, near Picher, Okla.

**U.S.S.R.&M. Increases Holdings.** The annual report of U.S.S.R.&M. for 1931, in addition to statistical information presented elsewhere in this issue, records the fact that in February of this year the company acquired two companies in the Bingham district of Utah, the Bingham Prospect and Lead Silver Mines. These properties are contiguous, and their acquisition has consolidated into one group an ownership of 5,100 acres in the district.

*New York, N. Y., April 3*

**Homestake Reserves Up.** Homestake, largest of United States gold producers, and one of the oldest as well, more than maintained its ore reserves at the mine, near Lead, S. D., during 1931, despite extraction of 1,403,939 tons of ore. At the end of the year, B. C. Yates, general manager, estimates that 15,116,178 tons of ore was blocked out and 672,630 tons was broken. Corresponding figures at the end of 1930 were 14,981,911 and 675,650 tons, respectively. Grade of ore handled at Homestake in 1931 was $6.36 in gold per ton.

**Phelps Dodge Curtails.** Owing to the large world stocks of copper and the low prices for the metal, Phelps Dodge Corporation will curtail its operations in Arizona for an indefinite period. The Ajo property will be shut down on April 24 and Morenci on July 1. With these properties closed Phelps Dodge will produce only at Bisbee, Ariz. After July 1, Phelps Dodge will be producing about 4,000,000 lb. of copper a month, equivalent to approximately 12 per cent of maximum rated output for the group as a whole. The production rate agreed upon recently by producers was 20 per cent of rated capacity.

Development in the Copper Queen properties of the company, at Bisbee, yielded favorable results. This unit now includes the mines formerly owned by Calumet & Arizona. All work has been stopped in the Sacramento division, the Warren concentrator has been closed, and only the Junction and Campbell mines (both formerly owned by C. & A.) are being operated.

At New Cornelia, operations have been curtailed with minimum expense and loss of efficiency. No new capital expenditures have been made. Suspension of operations at the Eighty-Five mine, near Lordsburg, N. M., has been followed by pulling pumps in preparation for an indefinite shutdown.

**Silver Purchase Recommended.** Details are available outlining a plan proposed by Mr. F. H. Brownell for concurrent though independent action in regard to silver by the United States, Canada, Mexico, and Australia. This has been or will be presented to the legislative bodies of the four countries, and is designed to effect an increase of currency in circulation and to improve the price. The proposal is made that each country shall offer to buy from its own nationals its own current mine production of silver at market price, to the extent to which it may be offered, within specified limits. The silver so bought may be (1) coined and issued, which would probably be done in Mexico; or (2) coined in whole or in part, and silver certificates issued against that coined, as would probably be done in the United States, Canada, and possibly Australia. Senator Key Pittman, of Nevada, introduced in the Senate of the United States, on Feb. 11, 1932, a bill (S. 3606) in accord with this general plan.

*Juneau, Alaska, March 15*

**Admiralty Alaska Drilling.** According to the annual report of Admiralty Alaska, work done during 1931 consisted of diamond drilling on the Mertie Lode, about 1,200 ft. of underground development, and preparation of camp buildings and equipment. Official estimates of ore reserves at this property, which is on Admiralty Island, near Juneau, put the total quantity of gold ore available at 6,620,000 tons, of which 5,250,000 tons is in the Mertie Lode. A small mill is now available, but the company plans to build a 1,000- or 2,000-ton unit. The balance sheet shows only $7,889 in cash available, so that further financing appears necessary.

## Mining Company Dividends for March, 1932

| Companies in the United States | Situation | Per Share | Total Disbursements |
|---|---|---|---|
| American Smelting & Refining, 6% pfd | Various | 1.50 Q | 262,500 |
| American Smelting & Refining, 7% pfd | Various | 1.75 Q | 875,000 |
| Eureka Standard, g, s | Utah | 0.03 Q | 45,000 |
| Freeport Texas Sulphur | Texas | 0.50 Q | 364,892 |
| Golden Cycle, g | Colorado | 0.40 Q | 66,000 |
| Hecla Mining, l, s | Idaho | 0.10 Q | 100,000 |
| Homestake Mining, g | S. Dakota | 0.65 M | 163,254 |
| Mayflower Associates, h | Various | 0.50 Q | 28,750 |
| Mohawk Mining, c | Michigan | 0.25 Q | 136,500 |
| National Lead | Various | 1.25 Q | 387,289 |
| National Lead, pfd. "A" | Various | 1.75 Q | 426,433 |
| St. Joseph Lead | Various | 0.15 Q | 292,729 |
| Sunshine Mining, s | Idaho | 0.02 Q | 30,000 |
| Texas Gulf Sulphur | Texas | 0.50 Q | 1,270,000 |
| Tintic Standard Mining, s, l | Utah | 0.05 | 57,665 |
| Companies in Canada | | | |
| Hollinger Consolidated Gold | Ontario | 0.05 FW | 246,000 |
| Lake Shore, g | Ontario | 0.50 Q | 1,000,000 |
| McIntyre-Porcupine | Ontario | 0.25 Q | 199,500 |
| Siscoe Gold | Quebec | 0.04 I | 198,000 |
| Total | | | $6,635,237 |

s, silver; l, lead; c, copper; n, nickel; g, gold; q, quicksilver; h, holding company; Q, quarterly; M, monthly; FW four-weeks' dividend payable in Canadian funds; I, initial.

# CANADA

*Montreal, April 2*

This year's meeting of the Canadian Institute of Mining and Metallurgy will be held in this city on April 5, 6, and 7. The central topic of the meeting is presented in Dr. Charles Camsell's paper, "Mineral Position of the British Empire." Dr. Camsell finds that, while the British Empire as a whole is better provided with mineral resources than any other part of the globe, the larger part of its mineral trade at present is conducted with foreign countries. This leaves a tremendous scope for the organization of inter-Empire trade. Dr. Camsell will be followed by Balmer Neilly on "Gold"; Stephen Leacock on "Gold and Silver"; Arthur Notman on "Copper"; and R. W. Brigstocke on "Metal Refining Facilities in Canada in Relation to World Markets."

The Governor General, His Excellency the Right Honorable the Earl of Besseborough, Patron of the Institute, will be the guest of honor at the banquet on April 7th. His address will be broadcast throughout the Dominion. F. W. Gray, President of the Institute, will introduce His Excellency, and A. B. Purvis, President of Canadian Industries Limited, will respond.

Hon. J. E. Perrault, Minister of Mines for Quebec, will open the meeting and welcome the visiting members to the province.

The financial aspects of mining will be discussed (and broadcast) at the luncheon on April 6th by A. W. Rogers, of the Canadian Bankers Association. On the succeeding day Stephen Leacock will give an address on the economics of gold and silver.

Distinguished guests from abroad will include Arthur Notman, of New York, President of the Mining and Metallurgical Society of America, who will bring up to date the discussion of copper that he presented in Ottawa last year. Another prominent guest from the United States will be Scott Turner, Director of the Bureau of Mines at Washington and President of the A.I.M.E., who spent many of his earlier years in the mining fields of this country. Charles McDermid, of London, secretary of the Institution of Mining and Metallurgy, will renew the acquaintance with Canada and Canadians that he commenced in 1927 as a leader in the Empire Mining and Metallurgical Congress.

An interesting social program will as usual characterize the convention.

*Toronto, Ont., April 1*

**Ashley Gold Builds New Mill.** The Ashley gold mine, in Bannockburn Township, which is owned by the Mining Corporation of Canada, will start construction work on its new mill this month. All mill and mine equipment and supplies, amounting to 1,300 tons, were transported by teams over snow roads for 50 miles during the months of February and March. Electric power is now available. The incline shaft has been continued to 585 ft. with a skip loading pocket installed at 575. With the sinking finished, drifting will be started on all levels.

**Sylvanite to Pay Bonus.** The directors of Sylvanite Gold plan to pay a bonus with the next semi-annual dividend of 2 per cent, payable June 30th. The bonus may amount to as much as the dividend and will represent the earnings from the sale of gold in New York funds. Production continues to average about $70,000 a month.

**Wright-Hargreaves Development Continues.** Recent diamond drilling on the Wright-Hargreaves property has proven an intersection of the north and south ore zones to a depth of 3,400 ft. and holes are now being drilled to cut the ore at 3,800 ft.; the lowest working level is at 3,000 ft. At the other end of the camp the Kirkland Lake Gold has intersected the vein by diamond drill at 5,000 ft. Production is running at the rate of approximately $50,000 a month, from which a good profit is being realized.

**McIntyre Operating on Full Time.** McIntyre mine, of Porcupine, is again operating at full capacity following the partial shutdown as the result of burning out the motor in the motor-generator set used for hoisting. During the three weeks of forced curtailment the mill treated 1,500 tons a day, compared with the previous rate of 2,000 tons.

**Howey's Record Good.** Howey Gold Mines, at Red Lake, in northwestern Ontario, is treating a lower-grade ore than any other Canadian gold mine and doing it at the lowest cost per ton. The mill is treating 900 tons a day, from which the recovery in February was $4.10 a ton. Operating costs during the same month were $2.48 a ton and it is stated that a further reduction in this figure is probable. These creditable results were obtained under the management of Fraser D. Reid, formerly manager of the Coniagas Mines, at Cobalt. Profits during the current year will, according to a current estimate, run between $400,000 and $500,000.

**Waite-Ackerman Reserves Up.** Annual report of Waite-Ackerman-Montgomery, operating in the Rouyn district, indicates an increase of about 20,000 tons in copper-ore reserves to 467,350 tons averaging 6 per cent copper. Zinc-ore reserves are unchanged. Development work, largely between the 500 and 700 levels, cost $193,220. Ore shipments from development were 1,011 tons averaging 11 per cent copper.

**Noranda's Reserves Soar.** Ore reserves of Noranda Mines, leading gold-copper producer of Quebec, increased greatly in 1931, the annual report of the company, which operates at Rouyn, Que., indicates. Ore of concentrating grade available on Dec. 31 totaled 6,350,000 tons averaging 1.54 per cent copper and $3.62 in gold per ton, compared with 4,448,000 tons at the end of 1930. Smelting ore was put at 3,580,000 tons (compared with 3,433,000 tons) averaging 7.10 per cent copper and $3.45 in gold, and fluxing ore at 1,030,000 tons (compared with 294,000 tons) averaging 0.32 per cent copper and $4.42 in gold per ton.

**Ashley to Start in 1932.** Production from the 150-ton cyanide plant being built at the Ashley Gold mining property, in Bannockburn Township, Ont., will probably start late this year, according to J. P. Watson, president of Mining Corporation of Canada, which controls the Ashley. The Ashley discovery was made in November, 1930, so that the deposit will be producing two years after its discovery. Electric power is already available for operations.

At the Cobalt and South Lorrain units of Mining Corporation, production of cobalt in 1931 was more than triple that of 1930. The favorable contract which the company had for the sale of cobalt terminated on Dec. 31, and operations at the mines are now restricted to extraction of high-grade silver ore and salvaging operations.

**Falconbridge Development.** Driving west along the ore zone on the 350 level of the Falconbridge Nickel property, near Sudbury, Ont., has indicated ore of better than average grade over an average width of about 40 ft. Ore reserves at the property have now increased to 2,725,000 tons averaging 2.3 per cent nickel and 0.94 per cent copper, despite extraction of 133,721 tons during 1931.

**Develop Nickel-Steel Process.** Of special interest to the nickel-copper industry of the Sudbury district is an announcement by the Department of Mines at Ottawa that a process has been developed by the department metallurgists for the semi-direct production of nickel-steel from Sudbury ores. The process was developed in experiments with 20 tons of ore from the Falconbridge nickel mine. In the present metallurgical practice used in treatment of the nickel ores, the nickel and copper are separated from the iron content in the ore, the nickel to be subsequently alloyed with iron again in the manufacture of nickel irons and steels. The steel produced is said to have compared favorably with steels made by the usual methods, when subjected to mechanical tests.

*Vancouver, B. C., March 25*

**Bralorne Ships Gold.** In the Bridge River area the new mill of the Bralorne Mining Company, operating the property of Lorne Gold Mines, Ltd., has been put into commission, and shipments of gold bullion and concentrate have been made already to Ottawa and the Tacoma smelter respectively. The present volume handled by the mill is about 75 tons a day, but it is expected to be increased to the normal 100 tons a day in the near future. Ore reserves estimated as blocked out at present on the King vein amount to about 21,000 tons, with an average grade of $13 a ton.

The new three-compartment shaft at Pioneer Gold, in the same district, has now been carried to a depth of between 300 and 400 ft. below the present lowest development level. The program provides for opening up levels down to 1,625 ft. below surface by the time the new mill is ready for operation at the beginning of November next.

**Reno Gold Mill Burned.** The mill of Reno Gold Mines, at Salmo, was totally destroyed by fire recently, halting production temporarily. The damage was covered by insurance, and steps are already being taken to build a new plant, as previous plans had called for increasing the capacity of the old treatment plant, which had a capacity of only 45 tons a day. It produced around $25,000 monthly. The new plant will be a 100-ton unit.

## PHILIPPINE ISLANDS

*Bagiuo, P. I., Feb. 26*

**Benguet Fire Halts Output.** An underground fire at the Antomok mine of Benguet Consolidated, in this district, has temporarily caused suspension of output. Resumption is expected within a few weeks. The fire did little damage to the mine, but four men were killed, including F. L. Roots, an engineer. Recent development in the mine has been favorable, and ore reserves were 467,600 tons, averaging $15 in gold per ton, at the end of 1931, an increase of more than 120,000 tons over the record for 1930. Milling capacity is being increased from 300 to 500 tons daily at a cost of $150,000. Construction of a new 3,000-hp. hydro-electric power plant is being considered. The company has acquired an option over the Gomok group.

**Balatoc Mill Expansion.** Delays in remodeling the Balatoc Mining mill, which is being doubled in capacity, have now been overcome, and the enlarged plant, in this district, is expected to be running March 15. Capacity will be 300 tons daily, compared with an average of better than 150 tons during 1931, when production set a new record. Recovery also improved, averaging 96 per cent of the gold content of the ore. Ore reserves have been increased to 392,466 tons averaging $19 a ton in gold, as of Dec. 31, 1931.

## MEXICO

*Mexico City, March 23*

**Mexico Buys Silver.** The Mexican government will purchase 23,000,000 oz. of silver over a period of twelve months. The contract was signed in this city on March 21 last by F. Moore, of Boston, vice-president of the U.S.S.&R.Co. The mint in this city has been reconditioned and will soon be coining 200,000 pesos daily—its full capacity. Old pesos and fifty-cent pieces are also being recoined. Delay in signing the contract is said to have been due to conditions of payment insisted upon by the mining company. The silver will be furnished by the Real del Monte company, of Pachuca, still the largest silver producer in the world and the property of U.S.S.&R. The announced intention of the government is to coin not a stipulated amount but sufficient to fill the business demands. Commencement of coinage it is presumed will smoke the hoarders out. During the last week some 4,000,000 pesos in bills were put into circulation, bringing the total paper circulation to this time up to 600,000,000 pesos. Bills are issued only to supply current demand.

**Readjustments Continue.** The new monetary law has not influenced the mining situation for the better. Benefits of exchange are offset by labor troubles, local taxes, and low prices. The larger companies operating throughout Mexico continue their policy of readjustments as far as possible. One of the latest was an arrangement at Fresnillo, Zacatecas, which permits the continuance of the mine operations there. Some hundred employees were discontinued; a reduction of wages of 10 per cent was accepted by the labor syndicates, and five days instead of six were substituted for a number of the workmen. This arrangement is for six months pending a new readjustment according to conditions at the end of that period. Some two thousand employees are thus enabled to retain their jobs.

**Arco Mines Reopen.** Advices from La Paz, Lower California, state that the old Arco mines, in the Calmalli district, are being reopened by a California syndicate and that a quantity of machinery has arrived and is being installed. Several old gold properties on the Pacific coast of the Peninsula are also in prospect of exploitation.

*Denver, Colo., March 21*

**Three Friends Enters Parral Area.** Three Friends Mining is taking over the Providencia mine, near the La Palmilla property, in the Parral lead-zinc district, Chihuahua, Mexico. After cleaning out the old workings, the company plans to build a selective-flotation mill. J. H. Boge is president and E. P. Albers is general manager of the company, which is incorporated in Colorado.

## AFRICA

*Johannesburg, South Africa, Feb. 27*

**Bid for Rand Lease Areas.** Bids have been sent in for two new lease areas on the Far East Rand. In his speech on the gold question before the House of Assembly, in Cape Town, Sir Ernest Oppenheimer stated that the Central Mining & Investment, Anglo-American, and New Consolidated Gold Fields groups have combined to make an offer for the new areas. Inclusion of Central Mining in the bidding indicates that the Vogelstruisbult area will be included in one of the plans for opening up these two areas.

*London, England, March 22*

**Rhokana Smelter Operating.** The first blister copper from the new Rhokana smelter, at N'Kana, Northern Rhodesia, was shipped on March 21. Smelter operation started on March 17 and, according to a cable from H. S. Munroe, consulting engineer of Rhokana, no metallurgical or mechanical difficulties have been experienced. All units of the company, including the mine and mill, are operating successfully.

**Kansanshi Grade Higher.** Drilling of the Kansanshi property of Rhodesia-Katanga during 1931 confirmed previous estimates of ore reserves and indicated that the grade of ore is 4.5 per cent copper, instead of 4.2 per cent, as had been previously estimated.

**Transvaal Gold Production.** February gold output from Transvaal mines was 914,012 oz., compared with 936,784 oz. in January. The total for the first two months of 1932 is 1,850,796 oz., or a gain of nearly 100,000 oz. over the first two months of 1931, when 1,754,513 oz. was produced.

*Brussels, Belgium, March 22*

**Crokaert Discusses Congo Resources.** At the opening of a Congo exhibition, at Brussels, on March 12, Paul Crokaert, Belgian Colonial Minister, stressed the richness of the Congo's mineral resources—of which gold, copper, tin, and diamonds are now the most important from a production standpoint. As mines furnish the government of the colony with most of its revenue, a policy of stimulating development of mineral resources is being followed.

**Kilo-Moto Gold,** chief gold producer of the Congo, increased its production in the first two months of 1932 to 951 kg., or about 100 kg. more than in the first months of 1931. King Albert of the Belgians is now visiting the gold fields of Kilo-Moto and of Minière des Grand Lacs, second largest gold producer. He made the trip to the Congo by airplane.

**Katanga Men Protest Curtailment.** The Association of Belgian Colonials in Katanga has sent a telegram to King Albert protesting the further reduction in operations at the Union Minière properties.

## SOUTH AMERICA

*La Paz, Bolivia, March 2*

**Huanchaca Mill Expansion.** The only property in Bolivia that appears to be expanding operations is the Huanchaca silver-zinc-lead mine. At this property, M. Hochschild & Company reports that work has started on enlarging the flotation mill from its present capacity of 15,000 metric tons monthly to about 24,000 tons monthly.

**Bolivia to Aid in Tin Research.** Bolivian tin producers have recently been asked to contribute to a fund destined for research to aid the tin industry, under the auspices of the Tin Producers' Association. Bolivia has been asked to contribute £7,700 annually. To raise this money, the local Miners' Association has requested the Bolivian government to place an additional tax of 10s. in export duties per ton of fine tin exported. Funds collected will be turned over to the T.P.A.

**Arafila Ground Leased.** Guggenheim Brothers has recently leased the old Arafila dredging property to individuals. The leasers plan to work the small amount of remaining tin ground by hand-sluicing methods.

**Peruvian Gold Mining.** Across the line in Peru, prospecting continues to be carried on by Empire drill in the Woods concession on the Inambari River.

*New York, N. Y., March 24*

**Patiño Cuts Costs Further.** Patiño Mines, leading tin producer of Bolivia, reduced costs at its mines at Llallagua in 1931 to £130 13s. per long ton of fine tin. These costs are after all charges, including smelting, transportation to London, and depreciation.

*Brussels, Belgium, March 22*

**Naltagua to Continue.** Operation of the Naltagua copper smelter, in central Chile, will be continued, H. de Peyerimhoff, chairman of the company, told stockholders at the annual meeting in Paris on March 19. The Chilean government has made arrangements to have the operations of the Disputada mine, in the Las Condes district, continued.

# AUSTRALIA

*Melbourne, Victoria, Feb. 15*

**Electrolytic Gold Plant Ready.** Electrolytic Gold, a Melbourne company which has just completed the erection of a plant at Stawell, Victoria, with a capacity of 500 tons of tailing per week, has installed special equipment for gold recovery by amalgamation.

**Broken Hill Pty.'s Gold Mines.** Broken Hill Proprietary is making good progress with the sinking of the new shaft at the Kingston gold mine, near Stawell. The shaft has reached a depth of 240 ft. and will be continued to 300 ft., at which depth the management expects that the lode will be met. Samples taken from the outcrops on the adjoining Wonga leases gave low assays, and the company does not propose to proceed any further with this property. In development work at Hannans North Mine, Western Australia, over which the company has an option, twenty men are employed. The results so far obtained are encouraging.

**Cloncurry Copper Suspends.** Cloncurry Copper, which installed the Murdoch leaching process at the Vulcan mine, Cloncurry, Queensland, has suspended operations after a few months' work. Costs much exceed the present price of copper, and, in addition, metallurgical difficulties have not allowed the estimated recovery of 95 per cent to be obtained.

**Bendigo Improvement.** The half-yearly reports of the two principal Bendigo gold mines, Ironbark and Hercules, are more satisfactory than for many years. Treating 4,118 tons of ore averaging 10.5 dwt., the Ironbark company made a net profit of £7,140, compared with £2,194 for the previous half year. Dividends totaling £6,000 were paid. Hercules reports a profit of £541 from the treatment of 1,362 tons of company ore, and 2,682 tons from tributors. The gold yield averaged 7 dwt. per ton.

**North Tasmanian to Reopen.** A company has been formed in Melbourne, with a nominal capital of £25,000, to reopen the North Tasmanian mine at Beaconsfield, Tasmania. The mine is north of the Tasmanian mine, which has paid £772,000 in dividends.

**Siamese Tin in Tasmania.** An English company, Siamese Tin, Ltd., has secured a large area of alluvial tin wash at St. Helens, on the northeast coast of Tasmania. To provide adequate water for sluicing, the company is to spend £25,000 in laying down a water race 28 miles long. On this work, 100 men will be employed.

**January Gold Output.** The production of gold in Western Australia for January was 44,038 oz., which is 16,731 oz. in excess of the output for the same month last year and the highest yield for January since 1921. The year has started well, and the State government is leasing another battery at Kalgoorlie to deal with the increase in prospectors' ore, which is mainly handled at government batteries.

**Lake View & Star's New Strike.** The general manager of Lake View & Star, J. F. Thorn, has stated that rich ore had been struck in a drill hole at a depth of 1,600 ft. on the Lake View lease. A crosscut has been put out to test the lode, but, so far, no driving has been done on the lode, and therefore, no definite statement of width and grade can be made. Mr. Thorn has admitted, however, that the ore was rich where it was intersected by the drill, but that the real value of the development had to be proved by driving on the lode.

**Goldfields Development Formed.** Goldfields Development, Ltd., a Queensland company, has been formed with a capital of £250,000 to acquire and test two prospecting areas, of five thousand acres each, on the Croydon gold field, North Queensland. The company plans to equip with a treatment plant the Miners Right mine, which has a shaft to a depth of 142 ft.; further to explore the Golden Gate mine at the 925 level, at an estimated cost of £10,000; and to resume sinking the shaft on the Iguana Reef.

**Big Blow to Get Mill.** A new company, Big Blow Gold, has been formed in Melbourne with a capital of £45,000, to purchase and equip the Big Blow mine, at Coolgardie, West Australia. The lode is 35 ft. wide and the ore has a recoverable value of 25s. per ton and upward.

*Melbourne, March 23 (By Cable)*

**Australian Gold Output.** Complete figures on Australian gold output in 1931 have just been released. The total production was 591,742 oz., compared with 466,579 oz. in 1930 and 430,629 oz. in 1929.

*Kalgoorlie, W. A., Feb. 27*

**North Kalgurli Opening Stopes.** At the North Kalgurli mine, which the managing director, C. A. Whitfield, is visiting, leading stopes have been taken off the various oreshoots on the 256, 366, 500, 600, and 700 levels for a length of 1,185 ft., and are now being timbered. This leaves 3,000 ft. of leading stope to be taken and timbered. When this work is completed, the mine will be in a position to produce on a large scale.

## Production Statistics

Recently issued annual reports contain the following data on metal production of the individual companies. Figures given are for the years ended Dec. 31, 1931, and Dec. 31, 1930, unless otherwise stated:

| | 1930 | 1931 |
|---|---|---|
| **Alaska Juneau** | | **Alaska** |
| Ore, short tons | 3,924,460 | 4,162,350 |
| Gold, oz. | 163,312 | 178,532 |
| Silver, oz. | 97,607 | 118,508 |
| Lead, tons | 1,320 | 1,655 |
| **American Smelting & Refining** (a) | | **Various** |
| Copper, short tons | 440,784 | 271,825 |
| Lead, tons | 497,832 | 363,507 |
| Zinc, tons | 66,040 | 53,486 |
| Gold, oz. | 1,760,702 | 1,454,744 |
| Silver, oz. | 85,515,993 | 65,125,555 |
| **Balatoc Mining** | | **Philippine Islands** |
| Ore, short tons | 52,577 | 57,675 |
| Gold bullion, value | $1,260,896 | $1,407,335 |
| **Benguet Consolidated** | | **Philippine Islands** |
| Ore, short tons | 114,786 | 112,524 |
| Gold bullion, value | $1,773,476 | $1,666,175 |
| **Bunker Hill & Sullivan** | | **Idaho** |
| Ore, short tons | 455,475 | 460,366 |
| Lead concentrate, tons | 88,467 | 89,839 |
| Lead content, per cent | 49.3 | 49.2 |
| Lead, tons (a) | 84,405 | 77,687 |
| Silver, oz (a) | 10,272,081 | 10,049,526 |
| Gold, oz. (a) | 46,000 | 44,841 |
| **Calumet & Hecla** | | **Michigan** |
| Ore, short tons | 2,776,675 | 2,063,653 |
| Tailing, tons | 1,545,000 | None |
| Copper, tons | 52,870 | 36,184 |
| **Christmas Copper** | | **Arizona** |
| Ore, short tons | 216,604 | 79,109 |
| Copper, tons | 3,462 | 1,224 |
| Silver, oz. | 33,806 | 9,530 |
| Gold, oz. | 1,007 | 301 |
| **Consolidated Metals** | | **California** |
| Quicksilver, flasks | 759 | 1,588 |
| **Falconbridge Nickel** | | **Canada** |
| Ore, short tons | 71,620 | 109,520 |
| Copper, tons | 636 | 913 |
| Nickel, tons | 1,469 | 2,263 |
| **Federal Mining & Smelting** | | **Idaho** |
| Ore, short tons | 791,443 | 291,054 |
| Lead, tons | 41,242 | 25,810 |
| Zinc, tons | 35,793 | 15,296 |
| Gold, oz. | 323 | 217 |
| **Gopeng Consolidated** (e) | | **F.M.S.** |
| Gravel, cu.yd. | 1,956,000 | 1,705,000 |
| Tin concentrate, tons | 846 | 731 |
| **Hecla Mining** | | **Idaho** |
| Ore, short tons | 310,879 | 235,901 |
| Lead, tons | 28,691 | 23,947 |
| Zinc, tons | 720 | 329 |
| Silver, oz. | 1,557,180 | 1,271,689 |
| **Homestake Mining** | | **South Dakota** |
| Ore, short tons | 1,364,456 | 1,403,939 |
| Gold bullion, value | $8,426,195 | $8,935,307 |
| **International Nickel** | | **Canada** |
| Ore, short tons | 2,041,801 | 1,580,355 |
| Copper, tons | 59,503 | 50,701 |
| Nickel, tons (b) | 43,056 | 24,212 |
| Platinum metals, oz. | 71,260 | 91,644 |
| **Isle Royale** | | **Michigan** |
| Ore, short tons | 510 262 | 353,075 |
| Copper, tons | 5,329 | 3,865 |
| **Kirkland Lake Gold** | | **Canada** |
| Ore, short tons | 52,106 | 52,628 |
| Gold, oz. | 25,764 | 28,315 |
| **Magma Copper** | | **Arizona** |
| Ore, short tons | 251,872 | 231,862 |
| Copper, tons | 15,779 | 14,380 |
| Gold, oz. | 8,519 | 7,513 |
| Silver, oz. | 830,009 | 701,576 |
| **Mining Corporation** | | **Canada** |
| Cobalt, lb. | 361,038 | 1,260,424 |
| Silver, oz. | 1,053,737 | 964,189 |
| **Niagara** (c) | | **Utah** |
| Ore, short tons | 11,038 | 39,402 |
| Copper, tons | (d) | 102 |
| Lead, tons | (d) | 4,087 |
| Zinc, tons | (d) | 4,723 |
| Gold, oz. | (d) | 13,426 |
| Silver, oz. | (d) | 350,756 |
| **Noranda Mines** | | **Canada** |
| Ore, short tons | 849,303 | 1,012,005 |
| Copper, tons | 37,755 | 31,005 |
| Gold, oz. | 117,393 | 253,363 |
| Silver, oz. | 691,920 | 558,801 |
| **Old Dominion** | | **Arizona** |
| Ore, short tons | 470,327 | (d) |
| Copper, tons | 8,798 | 5,674 |
| **Patino Mines** | | **Bolivia** |
| Ore, metric tons | 787,678 | 575,656 |
| Tin, long tons | 17,015 | 14,382 |
| **Petaling Tin** (e) | | **F.M.S** |
| Tin concentrate, long tons | 2,124 | 1,580 |
| **Phelps Dodge** (f) | | **Arizona, Mexico** |
| Copper, tons | 120,491 | 104,064 |
| Lead, tons | 76 | 272 |
| Gold, oz. | 63,392 | 90,720 |
| Silver, oz. | 2,052 930 | 4,128,671 |
| **Premier Gold** | | **Canada** |
| Ore, short tons | 256,836 | 242,317 |
| Gold, oz. | 90,084 | 82,394 |
| Silver, oz. | 2,760,787 | 1,718,376 |
| **U. S. Steel** | | **Tennessee, Brazil** |
| Manganese ore, long tons | 134,044 | 97,328 |
| Zinc concentrate, short tons | 12,336 | 15,159 |

(a) Includes material treated for other companies.
(b) Does not include nickel content of monel metal.
(c) Belongs to U. S. Smelting, data taken from tax report filed.
(d) Not available.
(e) For fiscal years ended Sept. 30, 1930, and Sept. 30, 1931.
(f) Includes material produced by Calumet & Arizona, with which P.D. merged.

# Copper Producers Agree on Further Cut in Output—Demand Quiet

General industrial activity failed to register any improvement in the third month of the year, which was reflected in continued unsettlement in commodity prices. The month was marked by renewed efforts to bring production of major non-ferrous metals below the current rate of consumption, and outstanding in this respect was the announcement made by copper producers that further curtailment had been agreed upon. Early in March a new all-time low was recorded in zinc; lead made a new low for the period of the depression. Copper showed little change on light offerings. The weighted index number of *E.&M.J.* for March was 49.24, the lowest level attained since this price indicator was established. A month ago the index number stood at 51.30, and a year ago at 68.03.

## Copper Settles at 6c.

The feature in copper was the announcement made on March 11 to the effect that producers had come to an understanding on the curtailment program as well as the export marketing plan. The reduction in output agreed upon—20 per cent of rated capacity—is calculated to bring the monthly total for world production down below 65,000 tons. From present indications production should decline to 55,000 tons, or even less, as a number of producers expect to curtail to a greater extent than that indicated, especially in the summer months. In fact, announcement was made that the properties owned by Phelps Dodge will be down to about 4,000,000 lb. a month after July 1, equivalent to approximately 12 per cent of maximum rated capacity. The new plan went into effect April 1.

Though no statistics have been made public on the status of the industry, information available to producers shows that world output during February dropped to about 70,000 tons. This figure is below the level aimed at last December, when it was agreed that output had to be reduced to 26½ per cent of capacity, and was accepted as evidence that producers no longer entertain any illusions over the necessity of correcting the statistical position of the market to bring about a higher selling basis. Consumption, at present, is estimated at 75,000 tons a month.

All special privileges were discarded in the new agreement, both as to the storage of excess production and the quotas in the export market. The export association went back to the rules that were in effect prior to Jan. 1. However, a more liberal interpretation of these rules was granted to custom smelters, which, in effect, allowed them to offer copper in the export market, whenever necessary, at slight concessions from the so-called official price.

An attempt was made during the month to incorporate a tariff on copper in the revenue bill, but this had to be abandoned. The tariff advocates have prepared a bill for a 5c. duty on copper and copper exports, and action on the proposal is expected to take place soon after the revenue measure has passed the House.

The domestic market settled at 6c. per pound, delivered Connecticut, with few producers anxious to include forward material at this price. Copper Exporters adjusted the export quotation on March 24, establishing the official price at 6¼c., c.i.f. basis, against the previous quotation of 6⅜c. Custom smelters on the same day withdrew the special price of 6⅛c., and held to the 6¼c. c.i.f. basis up to the close of the period. Export sales during March amounted to 19,880 long tons, against 25,960 long tons in February, and 16,354 long tons in January.

## Lead Declines

Shipments of lead to consumers were disappointing during March, and, with no appreciable change in the rate of production, the market developed further weakness. The price was reduced to 3c. per pound, New York, the contract level of A.S.&R., and 2.90c., St. Louis. In the last week of the month some good buying developed, which no doubt served to lend some support to the market. Further reduction in output is expected as a result of the very low prices now prevailing. Sales of virgin lead made for March shipment totaled about 23,500 tons, against 27,500 tons in February, and 29,000 tons in January.

The London market has been unsettled on freer offerings by producers. Demand has been quiet. The lead cartel has not been renewed. The London price, reduced to a U. S. currency basis, fell several points below 2c. per pound on more than one occasion. World lead output in February was 110,987 tons, against 121,092 tons in January, according to the American Bureau of Metal Statistics.

## Zinc Makes New Low

Prime Western zinc sold down to 2.75c. per pound, St. Louis, a new all-time low. The outlook for zinc seemed hopeless until the last week of the month, when rumors of further curtailment in output made the rounds of the market and caused some of the leading operators to offer the metal rather sparingly. Toward the close the price appeared to be quite firm at 2.80c., April-May shipment. Demand for zinc has not improved and, according to traders, another cut in output is necessary to support prices.

## Tin Weakens

The price of tin declined slightly more than 1c. per pound during the last month. Consumers were fair buy-

### Current Statstics of Production and Stocks of Copper, Lead, and Zinc

Data from American Bureau of Metal Statistics, American Zinc Institute, and Metallgesellschaft

*All Figures Except Tin Represent Tons of 2,000 Lb.*

| | 1931 | | | | | | | | | | 1932 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COPPER — North and South America** | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Jan. | Feb. |
| Production, refined, daily average | 2,292 | 3,350 | 3,313 | 3,276 | 3,110 | 2,909 | 2,890 | ..... | ..... | ..... | ..... | ..... |
| Domestic shipments | 75,865 | 54,567 | 45,265 | 50,217 | 43,144 | 45,816 | 40,459 | ..... | ..... | ..... | ..... | ..... |
| Foreign shipments | 36,797 | 32,218 | 26,684 | 33,251 | 26,321 | 29,016 | 22,124 | ..... | ..... | ..... | ..... | ..... |
| Stocks, blister and refined | 553,016 | 561,797 | 589,345 | 600,827 | 620,075 | 631,880 | 658,321 | ..... | ..... | ..... | ..... | ..... |
| **LEAD — United States** | | | | | | | | | | | | |
| Production, refined, from domestic ore | 41,775 | 35,498 | 39,519 | 30,708 | 32,157 | 34,144 | 31,966 | 36,546 | 31,671 | 33,576 | 32,180 | 28,081 |
| Production, secondary and foreign | 3,025 | 2,941 | 3,598 | 3,683 | 4,409 | 5,453 | 3,934 | 4,722 | 3,820 | 4,031 | 4,559 | 3,920 |
| Production, total, daily rate | 1,448 | 1,280 | 1,390 | 1,146 | 1,179 | 1,151 | 1,163 | 1,331 | 1,180 | 1,213 | 1,185 | 1,103 |
| Shipments reported | 36,761 | 35,324 | 34,081 | 37,054 | 42,219 | 38,590 | 38,059 | 34,276 | 31,216 | 30,297 | 27,867 | 26,319 |
| Stocks, end of month | 130,426 | 132,993 | 142,370 | 139,698 | 133,958 | 134,977 | 132,804 | 139,796 | 144,057 | 151,380 | 160,257 | 165,933 |
| **ZINC — United States** | | | | | | | | | | | | |
| Production, daily average | 1,043 | 971 | 971 | 783 | 689 | 692 | 712 | 699 | 684 | 709 | 723 | 742 |
| Domestic shipments | 35,224 | 27,418 | 25,831 | 27,604 | 28,460 | 23,599 | 20,902 | 21,163 | 20,327 | 23,005 | 22,472 | 21,896 |
| Export shipments | ..... | ..... | 20 | ..... | 20 | ..... | ..... | ..... | ..... | ..... | 31 | ..... |
| Stocks, end of month | 141,493 | 143,212 | 143,049 | 138,928 | 131,833 | 129,701 | 130,155 | 130,666 | 130,865 | 129,825 | 129,886 | 129,506 |
| **World Production Rate (Daily Average)** | | | | | | | | | | | | |
| Copper | 4,418 | 4,296 | 4,209 | 4,224 | 3,919 | 3,924 | 4,023 | ..... | ..... | ..... | ..... | ..... |
| Lead | 4,693 | 4,898 | 3,988 | 3,995 | 3,691 | 3,906 | 3,654 | 3,806 | 3,980 | 3,958 | 3,906 | 3,827 |
| Zinc | 3,574 | 3,429 | 3,212 | 3,127 | 2,860 | 2,766 | 2,815 | 2,740 | 2,728 | 2,604 | 2,609 | 2,631 |
| Tin (Metric Tons) | 436 | 441 | 426 | 439 | 401 | 416 | 349 | 352 | 325 | 360 | ..... | ..... |

ers on the decline, even though news from abroad was not particularly encouraging. The rise in sterling exchange and heavy selling in London, attributed to liquidation by French interests, brought out the lower level of prices. To meet the present low status of industrial activity, the tin group is considering another reduction in output.

## Silver Irregular

Silver fluctuated within narrow limits. The average price for March was slightly lower than in the preceding month. News to the effect that Mexico has contracted for a good quantity of metal for coinage purposes had little influence on the market. Speculative ardor in silver was dampened somewhat by the unfavorable trend in security markets. Production of silver in the United States during February amounted to 1,674,000 oz., against 1,909,000 oz. in January, according to the A.B.M.S.

## Lead and Zinc Concentrate

Zinc concentrate, Prime, basis 60 per cent, settled at $17 per ton in the Tri-State district. The market was depressed on the weakness in the metal. Lead concentrate was reduced to $22.50 @$27.50, basis 80 per cent.

## Other Metals

Quotations cover wholesale lots, f.o.b. New York, unless otherwise specified. London prices are according to latest mail advices, and at present are largely nominal in view of erratic sterling exchange.

ALUMINUM—Per lb., delivered, Alcoa commercial and mill ingot, 99 and 98 per cent, 23.30c.; Alcoa No. 12 alloy, 22c.; metallurgical ingot, 94 per cent plus, 23.30c.; 98@99 per cent, 22.90c. London, £95, less 2 per cent, per long ton, for 98 per cent ingots and bars.

ANTIMONY—Per lb., Chinese (duty paid) and American, spot 6.125c.; futures nominal at 5.75c.

BERYLLIUM—See Alloys.

BISMUTH—Per lb., in ton lots, 85c. London (dollar basis), 75c.

CADMIUM—Per lb., 55c. London, 2s. 3d. Nominal.

CHROMIUM — Per lb., 97 per cent grade, spot, 88c.; contract 83c. per lb. contained chromium, maximum 1 or 2 per cent iron. (Usually sold as ferrochrome.)

COBALT—Per lb.: Metal imported from Belgium, 97@99 per cent, $2.50 less 35 per cent for cash. On yearly requirements, usual rebate of 5 to 10 per cent, as to quantity. London quotes $3.65 per kilo, subject to usual discounts.

INDIUM—Per oz., 98½ per cent, $90@$100 per oz. Nominal.

IRIDIUM — Per oz., $80@$90 for 98@99 per cent sponge and powder. London, £19@£20.

LITHIUM—Per lb., 98@99 per cent, 100-lb. lots, $15.

## Average Metal Prices for March, 1932

| | |
|---|---|
| COPPER: | |
| Electrolytic, refinery | 5.763 |
| London, Standard, Spot | 33.039 |
| London, Electrolytic, Bid | 36.786 |
| LEAD: | |
| New York | 3.150 |
| St. Louis | 2.993 |
| London, Spot | 12.345 |
| London, Forward | 12.634 |
| SILVER: | |
| New York | 29.810 |
| London | 18.336 |
| Sterling Exchange | 363.463 |
| ZINC: | |
| St. Louis | 2.787 |
| London, Spot | 12.616 |
| London, Forward | 13.024 |
| TIN: | |
| Straits | 21.863 |
| London, Standard Spot | 129.810 |
| QUICKSILVER | 72.537 |
| ANTIMONY | 6.188 |
| PLATINUM, Refined | 40.000 |
| CADMIUM | 55.000 |
| ALUMINUM, 99 Per Cent Plus | 23.300 |

■

MAGNESIUM—Per lb., ingots (4x16 in.), 99.8 per cent, 30c. in carloads; 32c. in 100 lb. lots or more, l.c.l.; ⅜, ½, 1, and 2 lb. sticks, 5c. per lb. over ingot price; ⅛ and ¼ lb. sticks, 8c. per lb. extra.

MANGANESE—Per lb., 95@97 per cent, 42c. (Usually sold as ferromanganese.)

MOLYBDENUM—Per lb., in 10- to 50-lb. lots, C.P. powder, $9; 97 per cent, $4.50. (Usually sold as calcium molybdate or ferromolybdenum, which see.)

NICKEL—Per lb. electrolytic cathodes, 35c.; shot and ingot made from remelted electro, 36c. for single lots of spot metal. London, per long ton, £230 to £235, with prices nominal.

OSMIUM—Per oz., $65@$70. London, £17 to £18.

PALLADIUM—Per oz., $19@$21. London, £5, nominal.

PLATINUM—Per oz. Official price of leading interest, $40. Cash transactions between dealers and refiners several dollars less. London market nominal at £10 7s. to £10 13s. The average price of Colombian crude, basis 85 per cent platinum, for February, was $29.25 per oz.

QUICKSILVER—Per flask of 76-lb., $74 @$75. London quiet at £18 12s. per flask.

RADIUM—Per mg. radium content, $50 in lots of 4 grams or more, to $65 for 1 gram; smaller quantities, $70.

RHODIUM—Per oz., $35@$50.

RUTHENIUM—Per oz., $38@$48.

SELENIUM—Per lb., $1.80@$2, depending on quantity, for black, powdered, 99.5 per cent pure.

SILICON—Per lb., minimum 97 per cent Si, maximum 1 per cent Fe, spot, 16c.; contract, 14c.

TANTALUM—Per kilo, $91 for C.P. bar or sheet.

TELLURIUM—Per lb., $2.

THALLIUM—Per lb., $12.50@$15.

TITANIUM—Per lb. in 50- to 100-lb. lots, 75 per cent, $5.

TUNGSTEN—Per lb., contained tungsten, 98 per cent, powdered, $1.45.

## Metallic Ores

Prices in tons of 2,000 lb., or in "units" of 20 lb., unless otherwise stated.

ANTIMONY ORE—No sales reported. London, per long ton unit, 4s. 3d. for 60 to 65 per cent sulphide ore.

BERYLLIUM ORE—Per ton, minimum 10 per cent BeO, $20@$30, f.o.b. mines; minimum 12 per cent, $35.

CHROME ORE—Per long ton, c.i.f. Atlantic ports, Indian ores, $17.50 for 48@50 per cent $Cr_2O_3$ ore, and $19.50@$20 for 50@51 per cent ore. London, 80s. for 48 per cent Rhodesian.

COBALT ORE—Per lb. of Co, 12 to 14 per cent grade, 50c., f.o.b. cars, Ontario. Market nominal.

IRON ORE—Per long ton, Lower Lake ports. Lake Superior ores:

Mesabi, non-bessemer, 51½ per cent iron, $4.50. Old Range, non-bessemer, $4.65.

Mesabi, bessemer, 51½ per cent iron, $4.65. Old Range, bessemer, 51½ per cent, $4.80.

Eastern ores, cents per long ton unit, delivered at furnaces: Foundry and basic, 56 to 63 per cent, 10c.

Foreign ores, alongside docks Atlantic ports, cargo lots, cents per long ton unit:

North African and Swedish, low-phosphorus, 8@9c.

Spanish and North African, basic, 56@60 per cent, 7@8½c.

Swedish foundry or basic, 65@68 per cent, 8c.

Newfoundland foundry, 55 per cent iron, 8c. Nominal.

MANGANESE ORE—Per long ton unit of Mn, c.i.f. North Atlantic ports, cargo lots, exclusive of duty: Brazilian, 46@48 per cent Mn, 21c.; Chilean, 47 per cent minimum, 24, nominal; Indian, 48@50 per cent, 23c.; Caucasian, 52 @55 per cent, 24c.; South African, 52@54 per cent, 23@24c.; 50 to 52 per cent, 22@23c.; 44 to 46 per cent, 21c.

Per ton in carload lots:

Chemical grades, powdered, coarse or fine, minimum 80 per cent $MnO_2$, Brazilian or Cuban, $50 in carloads, to $60 barreled. Javan or Caucasian, 85 per cent minimum, $50@$60. Domestic, 70 to 72 per cent, $43@$50 in carloads, f.o.b. mines.

MOLYBDENUM ORE—Per lb. of contained $MoS_2$, nominally 42c., delivered Pittsburgh, for 75@85 per cent concentrate; 30c., c.i.f. European ports. Lon-

don, per long ton unit, nominal at 37s. to 38s. for 80@85 per cent concentrate.

TANTALUM ORE—Per lb., $Ta_2O_5$, $1.75 for 60 per cent concentrate.

TIN ORE — No market in United States. London quotes £9 to £9 10s. per ton returning charges on 60 per cent Bolivian ore.

TITANIUM ORE — Per gross ton, ilmenite, 45@52 per cent $TiO_2$, f.o.b. Atlantic seaboard, $10@$12, according to grade and impurities. Low-grade domestic, 32 to 35 per cent, about $7 @$8. Rutile, per lb., guaranteed minimum 94 per cent concentrate, 10c.

TUNGSTEN ORE—Per unit of $WO_3$, N. Y.; Chinese wolframite, $10.25@ $10.50, duty paid. Bolivian scheelite, $10.50. Domestic, $10@$10.50.

VANADIUM ORE—Per lb. $V_2O_5$ contained, 26c., f.o.b. shipping point.

ZIRCON ORE—Per ton, 55 per cent $ZrO_2$, f.o.b. Atlantic seaboard, $40@$45 in 30-ton lots. Crude granular zircon, $70, f.o.b. Suspension Bridge, N. Y.; milled, $90.

## Non-Metallic Minerals

**Prices received for non-metallic minerals vary widely and depend upon the physical and chemical characteristics of the commodity. Hence the following quotations can serve only as a general guide to the prices obtained by producers and dealers in different parts of the United States for their own product. In the last analysis the value of a particular non-metallic mineral can be ascertained only by direct negotiation between buyer and seller.**

**Tons of 2,000 lb. unless otherwise noted.**

AMBLYGONITE — Per ton, f.o.b. mines, 8@9 per cent $Li_2O$, $50@$60.

ASBESTOS — Per ton, f.o.b. Quebec mines, tax and bags included: Crude No. 1, $400 (nominal); crude No. 2, $200; spinning fibers, $75@$125; Magnesia and compressed sheet fibers, $70@$85; various grades shingle stock, $45@$60; various grades paper stock, $27.50@$35; cement stock, $15@$20; floats, $10@$15.

Per ton c.i.f. New York: Rhodesian crude No. 1, $170; No. 2, $120. Nominal.

Per ton, c.i.f. New York: Russian crude No. 1, $200@$225; No. 2, $150@ $175; No. 3, $125. Nominal.

Per ton, f.o.b. mines, Vermont: Shingle stock, $40@$45; paper stock, $30@$35; cement stock, $18@$22.

BARIUM CARBONATE (Witherite) — Per ton, 90 per cent 300 mesh, $42; 100 mesh, $39.

BARYTES—F.o.b. mines:

*California:* Crude, $7 per ton.

*Georgia:* Barytes ore, crude, $6@ $6.50 per long ton.

*Missouri:* Per ton, water ground and floated, bleached, $23, car lots, f.o.b. works. Crude ore, minimum 95 per cent $BaSO_4$, less than 1 per cent iron, $6; 1 per cent iron and 93 per cent $BaSO_4$, $5.50; low-grade, $4.50, f.o.b. mines.

BAUXITE—Per long ton: Domestic ore, chemical, crushed and dried, 55 to 58 per cent $Al_2O_3$, 1.5 to 2.5 per cent $Fe_2O_3$, $6.50@$8, f.o.b. *Alabama* and *Arkansas* mines. Other grades, 56 to 59 per cent $Al_2O_3$, 5 to 8 per cent $SiO_2$, $6@$7.50, f.o.b. *Arkansas* mines. Pulverized and dried, 56 to 59 per cent $Al_2O_3$, 8 to 12 per cent $SiO_2$, $10@ $12.25, f.o.b. *Arkansas* mines; abrasive grade, crushed and calcined, 78 to 84 per cent $Al_2O_3$, $14@$16, f.o.b. *Arkansas* mines.

Per metric ton, foreign, c.i.f. Atlantic ports: Dalmatian, 50 to 55 per cent $Al_2O_3$, 1 to 3 per cent $SiO_2$, $4.50@ $6. Istrian, 54 to 57 per cent $Al_2O_3$, 3 to 5 per cent $SiO_2$, $5.50@$6.50; French, 56 to 59 per cent $Al_2O_3$, 2 to 4 per cent $SiO_2$, $5.50@$7.

BENTONITE—Per ton, carload lots, f.o.b. *Wyoming* mines, dried and crushed, in bulk, $8; in bags, $10. F.o.b. Chicago, selected air-floated, $25.

BORAX—Per ton, granular, contract, $36; carload lots, $40, delivered.

CELESTITE—Per ton in carload lots, 90 per cent $SrSO_4$, finely powdered, $27.

CHINA CLAY (Kaolin)—Per ton, f.o.b. *South Carolina* mines, crude lump, No. 1, $4@$5; crushed, $6.90; pulverized, $9@$15.

*Florida,* washed and crushed, No. 1, $12.50; No. 2, $12.

*Delaware,* No. 1, $14.50.

Imported English, f.o.b. American ports: lump, $17@$21 in bulk.

DIATOMITE—Per ton, f.o.b. *Nevada,* crude, dried, in bags, $10; minus 40 mesh, $15; 300 mesh, $20; high temperature insulation, $30.

EMERY—Per ton, f.o.b. *New York,* domestic crude ore, first grade, $10. Other American ore, delivered to grinders, per gross ton, $16; Turkish and Naxos ore, $30@$35. F.o.b. *Pennsylvania,* in 350-lb. kegs, Turkish, Khasia, and Naxos grain emery, 6½c. per lb.; American, 3½c.

FELDSPAR — Per ton, f.o.b. *North Carolina,* potash feldspar, 200 mesh, white, $15, in bulk; soda feldspar, $18. F.o.b. *Maine,* potash feldspar, white, 200 mesh, $19, in bulk. Granular glass-spar, white, 20 mesh, f.o.b. *North Carolina,* $10.50 in bulk.

*Virginia,* No. 1, 325 mesh, $17; 200 mesh, $15@$16; 160 mesh, $14@$15; No. 1 glassmakers', $9.50, Spruce Pine basis; enamelers', $12.50@$14.50.

*New Mexico:* Crude clean No. 1 potash spar, $4.75; ground, $9.50.

FLUORSPAR—Per net ton, 85 per cent $CaF_2$, and not over 5 per cent $SiO_2$. *Kentucky* and *Illinois* mines, contract, freight allowed Pittsburgh basis: Washed gravel, $20.31; No. 2 lump, $22.31.

Ground fluorspar, f.o.b. *Illinois* mines, 95 to 98 per cent $CaF_2$ and not over 2½ per cent $SiO_2$, $30 in bulk; $34 in bags or barrels.

F.o.b. *Colorado* mines, 82-5, $10.

Foreign fluorspar, gravel, 85-5, $19.50 @$20 per gross ton, duty paid, Baltimore or Philadelphia.

FULLER'S EARTH — Per ton, f.o.b. *Colorado,* $18, various finenesses to minus 90 mesh.

F.o.b. *Georgia* or *Florida,* 30 to 60 mesh, $15; 15 to 30, $14.50; 200 up, $10; 100 up, $7.

GARNET—Per ton, f.o.b. *New Hampshire* mines; concentrate, $40; washed grades, $125.

*New York:* Adirondack garnet concentrates, $85.

Spanish grades, $60, c.i.f. port of entry.

GILSONITE — Per ton, carload lots, f.o.b. *Colorado.*

Brilliant black, $32.90; seconds (mine run), $25.50.

Selects, $30.50, f.o.b. Utah. Nominal.

GRAPHITE—Per lb., f.o.b. *New York:* Ceylon lump, 6½@7½c.; carbon lump, 3@6c.; chip, 5@6c.; dust, 3@4c.; Madagascar flake, 5@6c.

No. 1 flake, 8@16c.; No. 2, 5½c. upward; fine ground, 55 to 70 per cent carbon, 3c. upward; amorphous, 3c. upward.

Crude amorphous graphite, $12@$23 per ton, according to grade.

GREENSAND — Per ton, f.o.b. cars, *New Jersey:* Screened and bagged, best grade, in carload lots, $20.

GYPSUM—Per ton, f.o.b. mill, crushed rock, *Iowa,* $2.50; *Ohio* and *New York,* $3. Ground, *Ohio,* $4; *Iowa,* $6. Agricultural, $6@$7. Calcined, $6@$9.

IRON OXIDE (See Ocher)—Per lb.: Standard Spanish red, 3@4½c.; domestic earth, 2@4½c.

KAOLIN—See China Clay.

KIESELGUHR—See Diatomite.

LEPIDOLITE—Per ton, $50@$60 for ordinary grades. Nominal.

LIMESTONE—Per ton, f.o.b. shipping points, depending on location, either lump or crushed, 25c.@$1.75.

Agricultural, $1 up to $6 per ton, as to grade and point of shipment.

MAGNESITE—Per ton, f.o.b. *California,* dead-burned, $25. Kiln run, 93 per cent MgO (artificial periclase), $68; 88 per cent MgO, $35. Caustic, 95 per cent MgO, $45; 90 per cent, $40. *Washington:* Dead-burned grain magnesite, $22.

MICA—Per ton, f.o.b. *New Mexico,* scrap, white, $21; off color, $18. Punch, white, for disks, per lb., 10c.; for washers, 8c.

Per ton, f.o.b. *New Hampshire,* roofing mica, $23; snow, $34; 40 mesh white, $40; 60 mesh, $48; 100 mesh, 60; 200 mesh, $75. Clean dry mixed bench and mine scrap, $13.

Per lb., f.o.b. *North Carolina:* Punch, 3@5c.; 1½x2 in., 20@30c.; 2x2, 30@50c.; 2x3, 60@90c.; 3x3, $1 @$1.40; 3x4, $1.40@$1.80; 3x5, $1.50 @$2; 4x6, $2.25@$3; 6x8, $2.50@ $3.75; 8x10, $5@$7.50. These prices apply both to No. 1 and No. 2 mica. Black-stained mica takes a discount of 10 to 25 per cent from this schedule. White North Carolina mica, 70 mesh,

$60 to $80. Biotite, or black mica, $15 a ton, unground. White, Georgia, 300 mesh, $19.50; sericite, 300 mesh, $15 per ton.

MINERAL BLACK—(Graphitic shale)—Per ton, 325 mesh, 75 per cent carbon, $22.50, f.o.b. *Virginia.*

MONAZITE—Per ton, minimum 6 per cent $ThO_2$, $60.

OCHER—Per ton, f.o.b. *Georgia* mines, $17.50 in sacks; $21 in barrels. Buff clay, 98 per cent through 325 mesh, $18.

F.o.b. *Virginia*, dark yellow, 300 mesh, 60 per cent ferric oxide, in jute bags, $19.50.

PHOSPHATE—Per long ton, f.a.s. or f.o.b. mines:

*Florida*, pebble, f.a.s., for export: 76@77 per cent, $7.15; 75 per cent, $6.40; 74@75 per cent, $6.15; 70 per cent, $4.65; 68 per cent, $4.10.

*Florida*, pebble, domestic: 76@77 per cent, $6.50; 74@75 per cent, $5.50; 72 per cent, $4.50; 70 per cent, $4.

*Tennessee*, ground lime phosphate, 80 per cent through 300 mesh, 33 per cent $P_2O_5$, $12.80 per net ton, bags extra. Rock phosphate, 29 per cent $P_2O_5$, 200 mesh, $9.50. Furnace lump, $6.25.

POTASH—Per ton, contracts:

| | Bags | Bulk |
|---|---|---|
| Muriate of potash, 80@85 per cent, basis 80 per cent | $37.15 | $35.55 |
| Sulphate of potash, 90@95 per cent, basis 90 per cent | 48.25 | 46.65 |
| Sulphate of potash-magnesia, 48@53 per cent, basis 48 per cent | 27.80 | 26.20 |
| Manure salt, 30 per cent | 22.15 | 19.15 |
| Manure salt, 20 per cent | 15.65 | 12.65 |
| Kainit, 14 per cent | 12.70 | 9.70 |

Prices are delivered to Atlantic ports. Discounts up to 4 per cent for early shipment. Spot prices, $1.25@$1.50 per ton higher than on contract.

PUMICE STONE—Per lb., f.o.b. New York or Chicago, in barrels, powdered, 2½@4c.; lump, 5@7c.

PYRITES—Per long ton unit of sulphur, c.i.f. United States ports, guaranteed 48 per cent sulphur, Spanish, 12c., nominal.

QUARTZ ROCK CRYSTALS—For fusing, all sizes, $250 per ton. Prisms for piezo-electrical and optical use command premium.

SILICA—Per ton, water ground and floated, in bags, f.o.b. *Illinois:* 325 mesh, $16@$40 for 92 to 99½ per cent grades. Dry ground, air-floated, 325 mesh, 92@99½ per cent silica, $14@$30. Glass sand f.o.b. producing plant, $1.25@$5 per ton; molding sand, 50c.@$3.50; blast sand, $1.75@$6. *California:* $5 for quartz and $2.50 for sand.

STRONTIANITE—Per ton, lump in carload lots, minimum 90@92 per cent $SrCO_3$, $100.

SULPHUR—Per long ton for domestic market, $18 f.o.b. Texas mines.

TALC—Per ton, carload lots, f.o.b. works, containers included unless otherwise specified:

*New Jersey:* Soapstone, ground, $10 @$12.

*New York:* Double air floated, short fiber, 200 mesh, $13.75; 325 mesh, $14.75.

*Vermont:* 99 per cent through 200 mesh, extra white, bulk basis, $7.50@$8; 97 to 98 per cent through 200 mesh, medium white, $6.50@$7. Packing in paper bags, $1 per ton extra.

*Virginia:* 200 mesh, $4.60@$5.50, 325 mesh, $8@$9.25.

TRIPOLI—Per ton, burlap bags, paper liners, minimum carload 30 tons, f.o.b. *Missouri:* Once ground through 40 mesh, rose and cream colored, $15. Double ground through 110 mesh, rose and cream, $17. Air-floated through 200 mesh, rose and cream, $25.

WHITING—Per ton, f.o.b. *Georgia*, white, 300 mesh, $7.

## Metallic Compounds

ARSENIOUS OXIDE (White arsenic)—Per lb., 4c., delivered, all positions.

CALCIUM MOLYBDATE OR MOLYTE—Per lb. of contained Mo, 85c.

COBALT OXIDE—Per lb., black oxide, 70@71 per cent grade, $1.35.

COPPER SULPHATE (Blue Vitriol)—Per lb., in car lots, 2.75c. for either large or small crystals.

SODIUM NITRATE—Per 100 lb., crude natural, in bags ex vessel, Atlantic ports, $1.77.

SODIUM SULPHATE (Salt Cake)—Per ton, bulk, f.o.b. works, $16@$18.

ZINC OXIDE—Per lb. in bags, in car lots: Lead-free, 5¾c.; 10, 20 or 35 per cent leaded grades, 5¼c.; French red seal, in bags, 8⅝c.

ZIRCONIUM DIOXIDE—Per lb., carload lots, commercial, 38@43c.

## Refractories

CHROME BRICK—Per ton, f.o.b. shipping point, $42.50. Grecian refractory ore, $15 per net ton, f.o.b. Chester, Pa.

FIRECLAY BRICK—Per M., first quality, $38, *Ohio, Kentucky, Central Pennsylvania;* second quality, $30; first quality, *Missouri*, $35.

MAGNESITE—Brick, per ton, f.o.b. works, 9-in. straights, $61.50. Dead-burned grain, $38.50, f.o.b. Chester, Pa., or Baltimore.

SILICA BRICK—Per M., *Pennsylvania*, $38; *Alabama*, $50; *Illinois* and *Indiana*, $47.

ZIRKITE—Per lb., powdered, 65@70 per cent $ZrO_2$, 3½c. Brick, straights, 80c.@$1 each.

## Rolled Metals

COPPER—Per lb., sheets, hot-rolled, 15⅜c.; wire, f.o.b. mill, 8c.

LEAD SHEETS—Per lb., full rolled, 6¼c.; clipped, 6½c.

MONEL METAL—Per lb., sheets, full finished, 42c.; strip, cold-rolled, 45c.; rods, hot-rolled, 35c.

MUNTZ METAL—Per lb., rods, 11¼c.; sheets, 14⅝c.

NICKEL—Per lb., sheets, full finished, 52c.; rods, hot-rolled, 45c.

NICKEL SILVER—Per lb., sheets, 10 per cent, 20⅝@21c.; 18 per cent, 24⅛@24½c. Wire and rods, 10 per cent, 24⅛c.; 15 per cent, 28⅛c.; 18 per cent, 31⅝c.

PHOSPHOR BRONZE—Per lb., sheets and rods, 5 per cent tin, 26⅛c.; wire, 5 per cent, 26⅝c.; 10 per cent, 31⅛c.

ZINC SHEETS—Per lb., 9c., f.o.b. works; ribbon, 8½c.; 7 per cent discount on orders for 18 tons or more.

## Alloys

BERYLLIUM-COPPER—Per lb., containing 12.5 per cent of Be, $6.35.

FERROCHROME—Per lb. of contained chromium, 4 to 6 per cent carbon, 66 to 70 per cent chromium, 10c., delivered, on contract; spot, ton lots, 10½c. Containing 2 per cent carbon, 67 to 72 per cent chromium, 17c.; maximum 0.10 per cent carbon, 23½c.

FERROMANGANESE—Per gross ton, furnace: domestic and foreign, 78@82 per cent, $72@$75, contracts, depending on quantity. Spiegeleisen, 19@21 per cent, $27 for spot carloads.

FERROMOLYBDENUM—Per lb. of Mo, f.o.b. shipping point, 50@60 per cent Mo, 95c.

FERROPHOSPHORUS—Per gross ton, 18 per cent P, $91; electrolytic, 24 per cent, $122.50, f.o.b. *Alabama* and *Tennessee.*

FERROSILICON—Per gross ton, delivered, 50 per cent, $77.50; 75 per cent, $126; 14@16 per cent, $31, f.o.b. Niagara Falls, N. Y. Spot shipments $5@$10 per ton higher on 50 and 75 per cent grades.

FERROCARBONTITANIUM—Per ton, $140, f.o.b. producer's plant, carlots.

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent W, $1@$1.10, f.o.b. works.

FERROVANADIUM—Per lb. of V contained, delivered, $3.05@$3.30.

SILICOMANGANESE—Per long ton, carload contracts, delivered, $105 for maximum 2½ per cent carbon; $115 for maximum 1 per cent carbon.

SILICON ZIRCONIUM—Per lb., 47@52 per cent Si, 35@40 per cent Zr, 16@19c.

ZIRCONIUM FERROSILICON—Per gross ton, 12@15 per cent Zr, 39@43 per cent Si, $97.50@$105.

## Iron, Steel, and Coke

IRON—Per gross ton, Valley furnaces: Bessemer, $15; basic, $14.50; and No. 2 foundry, $15.

STEEL—Per gross ton, base prices, Pittsburgh, billets and slabs, $27; bars, plates, and structural shapes, per 100 lb., $1.50.

COKE—Per ton, Connellsville furnace, $2.25@$2.35. Connellsville foundry, $3.25@$4.25. Birmingham furnace, $3.50@$4.50. Byproduct coke, Ohio and Kentucky (Connellsville basis), $5.50; Buffalo and Detroit, $8@$8.50; Birmingham foundry, $5.

# Daily and Average Monthly Prices of Metals

## March, 1932

### United States Market

| March | Electrolytic Copper, Refinery | Straits Tin New York | Lead New York | Lead St. Louis | Zinc St. Louis |
|---|---|---|---|---|---|
| 1 | 5.525 | 21.900 | 3.25 | 3.05 | 2.75 |
| 2 | 5.525 | 22.250 | 3.25 | 3.05 | 2.75 @2.80 |
| 3 | 5.525@5.650 | 22.350 | 3.25 | 3.05 | 2.80 |
| 4 | 5.775 | 22.300 | 3.25 | 3.05 | 2.775@2.80 |
| 5 | 5.775 | 22.350 | 3.25 | 3.05 | 2.775@2.80 |
| 7 | 5.775@6.025 | 22.300 | 3.25 | 3.05 | 2.775@2.80 |
| 8 | 5.775@6.025 | 22.125 | 3.25 | 3.05 | 2.80 |
| 9 | 5.775@6.025 | 22.300 | 3.25 | 3.05 | 2.80 |
| 10 | 5.775 | 21.900 | 3.25 | 3.05 | 2.80 |
| 11 | 5.775 | 22.00@22.05 | 3.25 | 3.05 | 2.80 |
| 12 | 5.775 | 22.00@22.05 | 3.25 | 3.05 | 2.80 |
| 14 | 5.775 | 21.80@21.875 | 3.25 | 3.05 | 2.80 |
| 15 | 5.775 | 21.65@21.70 | 3.15 | 3.00 | 2.80 |
| 16 | 5.775 | 21.800 | 3.15 | 3.00 | 2.80 |
| 17 | 5.775 | 21.650 | 3.15 | 3.00 | 2.75 @2.80 |
| 18 | 5.775 | 21.875 | 3.15 | 3.00 | 2.75 |
| 19 | 5.775 | 21.900 | 3.15 | 3.00 | 2.75 @2.80 |
| 21 | 5.775 | 21.700 | 3.15 | 3.00 | 2.75 @2.80 |
| 22 | 5.775 | 21.750 | 3.15 | 3.00 | 2.75 @2.80 |
| 23 | 5.775 | 21.800 | 3.00 | 2.90 | 2.75 @2.80 |
| 24 | 5.775 | 21.75@21.90 | 3.00 | 2.90 | 2.75 @2.80 |
| 25 | 5.775 | 21.70@21.90 | 3.00 | 2.90 | 2.75 @2.80 |
| 26 | 5.775 | 21.70@21.90 | 3.00 | 2.90 | 2.775@2.80 |
| 28 | 5.775 | 21.900 | 3.00 | 2.90 | 2.775@2.80 |
| 29 | 5.775 | 21.15@21.25 | 3.00 | 2.90 | 2.80 |
| 30 | 5.775 | 21.200 | 3.00 | 2.90 | 2.80 |
| 31 | 5.775 | 20.750 | 3.00 | 2.90 | 2.80 |
| Av. for month | 5.763 | 21.863 | 3.150 | 2.993 | 2.787 |
| **Averages for Week** | | | | | |
| March | | | | | |
| 2 | 5.650 | 22.088 | 3.438 | 3.233 | 2.788 |
| 9 | 5.806 | 22.288 | 3.250 | 3.050 | 2.794 |
| 16 | 5.775 | 21.877 | 3.217 | 3.033 | 2.800 |
| 23 | 5.775 | 21.779 | 3.125 | 2.983 | 2.771 |
| 30 | 5.775 | 21.621 | 3.000 | 2.900 | 2.788 |
| **Calendar Week Averages** | | | | | |
| March | | | | | |
| 5 | 5.619 | 22.208 | 3.292 | 3.092 | 2.783 |
| 12 | 5.838 | 22.113 | 3.250 | 3.050 | 2.798 |
| 19 | 5.775 | 21.790 | 3.167 | 3.008 | 2.783 |
| 26 | 5.775 | 21.779 | 3.050 | 2.933 | 2.777 |

### Silver, Gold, and Sterling Exchange New York and London

| March | Sterling Exchange "Checks" | Sterling Exchange "90-Day" Demand | Silver New York | Silver London | Gold, London |
|---|---|---|---|---|---|
| 1 | 348.000 | 349.250 | 31.000 | 19.7500 | 118s 10d |
| 2 | 348.000 | 349.500 | 30.500 | 19.5000 | 118s 10d |
| 3 | 348.500 | 350.500 | 30.250 | 19.3750 | 118s 9d |
| 4 | 350.000 | 352.000 | 30.250 | 19.2500 | 118s 2d |
| 5 | 350.750 | 353.000 | 30.250 | 19.1875 | ..... |
| 7 | 352.500 | 356.000 | 30.250 | 19.0625 | 117s ..d |
| 8 | 365.500 | 368.750 | 30.250 | 18.5000 | 115s 8d |
| 9 | 368.250 | 369.250 | 29.500 | 17.5000 | 110s 5d |
| 10 | 366.500 | 368.000 | 29.750 | 17.8750 | 112s 3d |
| 11 | 362.750 | 363.250 | 29.750 | 18.0625 | 113s 8d |
| 12 | 362.500 | 363.375 | 29.875 | 18.1875 | ..... |
| 14 | 362.250 | 362.750 | 30.000 | 18.4375 | 114s ..d |
| 15 | 362.250 | 363.500 | 29.750 | 18.2500 | 114s ..d |
| 16 | 362.125 | 363.750 | 29.750 | 18.1250 | 114s ..d |
| 17 | 361.375 | 362.250 | 29.750 | 18.0000 | 114s 5d |
| 18 | 361.375 | 362.625 | 29.625 | 18.0625 | 114s 4d |
| 19 | 363.500 | 364.750 | 29.500 | 18.0625 | ..... |
| 21 | 364.000 | 365.500 | 28.875 | 17.8125 | 112s 10d |
| 22 | 363.500 | 364.750 | 29.000 | 17.7500 | 113s 1d |
| 23 | 363.875 | 365.625 | 29.375 | 18.1875 | 113s 2d |
| 24 | 370.500 | 372.000 | 29.500 | 17.9375 | 112s 2d |
| 25 | 369.500 | 371.000 | 29.500 | Holiday | |
| 26 | 375.250 | 377.250 | 29.500 | Holiday | |
| 28 | 380.000 | 381.750 | 29.625 | Holiday | |
| 29 | 378.500 | 381.500 | 30.000 | 17.6875 | 108s 11d |
| 30 | 374.750 | 376.750 | 29.750 | 17.8750 | 110s 5d |
| 31 | 377.500 | 379.500 | 29.750 | 17.6250 | 109s 1d |
| Av. for month | 363.463 | ..... | 29.810 | 18.336 | ..... |
| **Averages for Week** | | | | | |
| March | | | | | |
| 2 | 347.917 | ..... | 30.729 | ..... | ..... |
| 9 | 355.917 | ..... | 30.125 | ..... | ..... |
| 16 | 363.063 | ..... | 29.813 | ..... | ..... |
| 23 | 362.938 | ..... | 29.354 | ..... | ..... |
| 30 | 374.750 | ..... | 29.646 | ..... | ..... |

Calendar week averages: New York Silver, March 5th, 30.521c.; 12th, 29.896c. 19th, 29.729c.; 26th, 29.292c.

### London Market

| March | Copper Standard Spot | Copper Standard 3 Mo. | Copper Electrolytic (Bid) | Tin Spot | Tin 3 Mo. | Lead Spot | Lead 3 Mo. | Zinc Spot | Zinc 3 Mo. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 32.3125 | 32.7500 | 36.50 | 137.750 | 140.000 | 12.4375 | 13.0000 | 13.0625 | 13.4375 |
| 2 | 33.1250 | 33.6250 | 37.25 | 138.750 | 141.000 | 12.5625 | 13.1875 | 13.3750 | 13.7500 |
| 3 | 34.0000 | 34.5000 | 38.00 | 139.625 | 141.625 | 12.8125 | 13.4375 | 13.5625 | 14.0000 |
| 4 | 34.3750 | 34.8125 | 39.00 | 139.750 | 141.625 | 13.0000 | 13.5625 | 13.5000 | 13.8750 |
| 7 | 34.7500 | 35.1250 | 40.00 | 137.500 | 139.125 | 13.0000 | 13.5000 | 13.2500 | 13.7500 |
| 8 | 33.8750 | 34.3750 | 39.00 | 133.000 | 134.500 | 12.8750 | 13.3750 | 12.9375 | 13.3750 |
| 9 | 32.8750 | 33.2500 | 37.00 | 129.875 | 131.500 | 12.6250 | 13.1875 | 12.7500 | 13.1875 |
| 10 | 33.1250 | 33.5000 | 36.25 | 130.375 | 132.000 | 12.6875 | 13.1875 | 12.8125 | 13.2500 |
| 11 | 32.8750 | 33.1250 | 36.25 | 130.625 | 132.250 | 12.5000 | 13.0000 | 12.6875 | 13.1875 |
| 14 | 33.6250 | 33.7500 | 36.75 | 129.750 | 131.375 | 12.6250 | 13.0000 | 12.6875 | 13.1875 |
| 15 | 33.3125 | 33.2500 | 36.50 | 128.000 | 129.750 | 12.3125 | 12.7500 | 12.5000 | 13.0000 |
| 16 | 33.3750 | 33.2500 | 36.50 | 129.750 | 131.375 | 12.1875 | 12.3750 | 12.1875 | 12.6875 |
| 17 | 32.8750 | 32.8750 | 36.50 | 128.500 | 130.125 | 12.5000 | 12.6875 | 12.5625 | 12.9375 |
| 18 | 33.6250 | 33.6250 | 36.50 | 130.125 | 131.875 | 12.5000 | 12.7500 | 12.9375 | 13.3125 |
| 21 | 32.6875 | 32.7500 | 36.50 | 127.375 | 129.000 | 12.1250 | 12.3750 | 12.6250 | 13.0000 |
| 22 | 32.8125 | 32.9375 | 36.50 | 127.750 | 129.500 | 12.0000 | 12.1250 | 12.4375 | 12.8125 |
| 23 | 33.0625 | 33.1875 | 36.50 | 128.500 | 130.250 | 12.1875 | 12.2500 | 12.4375 | 12.7500 |
| 24 | 32.7500 | 32.8750 | 37.00 | 126.375 | 128.125 | 11.8750 | 11.8125 | 12.2500 | 12.5625 |
| 25 | Holiday | | | | | | | | |
| 28 | Holiday | | | | | | | | |
| 29 | 31.8750 | 32.1250 | 35.00 | 118.125 | 119.500 | 11.5625 | 11.3750 | 11.3750 | 11.7500 |
| 30 | 31.6250 | 31.7500 | 35.00 | 120.500 | 122.000 | 11.7500 | 11.5000 | 11.7500 | 12.0625 |
| 31 | 30.8750 | 31.0000 | 34.00 | 114.000 | 115.750 | 11.1250 | 10.8750 | 11.2500 | 11.6250 |
| Average for month | 33.039 | ..... | 36.786 | 129.810 | ..... | 12.345 | 12.634 | 12.616 | 13.024 |

**The United States quotations** are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices of domestic class are in cents per pound.

**Copper, lead and zinc quotations** are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

**Quotations for zinc** are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight differential. Contract prices for High-Grade zinc delivered in the East and Middle West are 1c. above St. Louis

prices for the Prime Western grade.

**Quotations for lead** reflect prices obtained for common lead, and do not include grades on which a premium is asked.

**London prices for lead and zinc are** the official prices for the morning session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton (2,240 lb.).

**New York silver quotations** are as reported by Handy & Harman and are in cents per troy ounce of silver, 999 fine. London silver quotations are in pence per troy ounce of bar silver, 925 fine. Sterling prices represent forenoon market demand. Cables command a premium.

## Silver and Sterling Exchange

| | New York | | London Spot | | Sterling Exchange | |
|---|---|---|---|---|---|---|
| | 1931 | 1932 | 1931 | 1932 | 1931 | 1932 |
| January | 29.423 | 29.780 | 13.810 | 19.623 | 485.260 | 342.515 |
| February | 26.773 | 30.136 | 12.432 | 19.573 | 485.551 | 345.141 |
| March | 29.192 | 29.810 | 13.524 | 18.336 | 485.596 | 363.463 |
| April | 28.279 | ..... | 13.120 | ..... | 485.764 | ..... |
| May | 27.650 | ..... | 12.858 | ..... | 486.188 | ..... |
| June | 27.250 | ..... | 12.707 | ..... | 486.291 | ..... |
| July | 28.255 | ..... | 13.197 | ..... | 485.349 | ..... |
| August | 27.524 | ..... | 12.815 | ..... | 485.284 | ..... |
| September | 28.180 | ..... | 14.101 | ..... | 451.245 | ..... |
| October | 29.538 | ..... | 17.153 | ..... | 388.029 | ..... |
| November | 32.223 | ..... | 19.393 | ..... | 371.130 | ..... |
| December | 30.120 | ..... | 20.023 | ..... | 336.798 | ..... |
| Year | 28.700 | ..... | 14.594 | ..... | 452.707 | ..... |

New York quotations, cents per ounce troy, 999 fine. London, pence per ounce, sterling silver, 925 fine. Sterling exchange in cents.

## Copper

| | F.O.B. Refinery | | London Spot | | | |
|---|---|---|---|---|---|---|
| | Electrolytic | | Standard | | Electrolytic | |
| | 1931 | 1932 | 1931 | 1932 | 1931 | 1932 |
| January | 9.838 | 7.060 | 44.938 | 39.459 | 47.524 | 46.200 |
| February | 9.724 | 5.965 | 45.372 | 36.917 | 47.950 | 41.381 |
| March | 9.854 | 5.763 | 44.818 | 33.039 | 47.699 | 36.786 |
| April | 9.392 | ..... | 42.694 | ..... | 45.375 | ..... |
| May | 8.665 | ..... | 38.897 | ..... | 42.175 | ..... |
| June | 8.025 | ..... | 35.827 | ..... | 38.966 | ..... |
| July | 7.698 | ..... | 34.402 | ..... | 37.293 | ..... |
| August | 7.292 | ..... | 32.572 | ..... | 35.388 | ..... |
| September | 6.988 | ..... | 31.503 | ..... | 36.148 | ..... |
| October | 6.775 | ..... | 34.957 | ..... | 41.000 | ..... |
| November | 6.558 | ..... | 35.854 | ..... | 41.190 | ..... |
| December | 6.580 | ..... | 38.273 | ..... | 44.409 | ..... |
| Year | 8.116 | ..... | 38.342 | ..... | 42.093 | ..... |

New York quotations, cents per pound. London, pounds sterling per long ton.

## Lead

| | New York | | St. Louis | | London | | | |
|---|---|---|---|---|---|---|---|---|
| | 1931 | 1932 | 1931 | 1932 | 1931 Spot | 1931 3 Mos. | 1932 Spot | 1932 3 Mos. |
| January | 4.802 | 3.750 | 4.604 | 3.550 | 13.872 | 13.905 | 15.084 | 15.128 |
| February | 4.552 | 3.712 | 4.340 | 3.499 | 13.444 | 13.550 | 14.560 | 14.571 |
| March | 4.527 | 3.150 | 4.276 | 2.993 | 13.128 | 13.355 | 12.345 | 12.634 |
| April | 4.412 | ..... | 4.164 | ..... | 12.375 | 12.606 | ..... | ..... |
| May | 3.818 | ..... | 3.651 | ..... | 11.491 | 11.778 | ..... | ..... |
| June | 3.917 | ..... | 3.761 | ..... | 11.582 | 11.952 | ..... | ..... |
| July | 4.400 | ..... | 4.225 | ..... | 12.731 | 12.899 | ..... | ..... |
| August | 4.400 | ..... | 4.225 | ..... | 11.944 | 11.994 | ..... | ..... |
| September | 4.400 | ..... | 4.217 | ..... | 11.932 | 12.026 | ..... | ..... |
| October | 3.964 | ..... | 3.773 | ..... | 13.227 | 13.270 | ..... | ..... |
| November | 3.937 | ..... | 3.758 | ..... | 14.577 | 14.491 | ..... | ..... |
| December | 3.792 | ..... | 3.592 | ..... | 15.188 | 15.361 | ..... | ..... |
| Year | 4.243 | ..... | 4.049 | ..... | 12.958 | 13.099 | ..... | ..... |

New York and St. Louis quotations, cents per pound. London, pounds sterling per long ton.

## Tin

| | New York | | London | |
|---|---|---|---|---|
| | 1931 | 1932 | 1931 | 1932 |
| | Straits | | Spot | |
| January | 26.137 | 21.804 | 115.798 | 140.219 |
| February | 26.315 | 22.018 | 117.919 | 139.143 |
| March | 27.065 | 21.863 | 121.852 | 129.810 |
| April | 25.222 | ..... | 112.775 | ..... |
| May | 23.221 | ..... | 104.331 | ..... |
| June | 23.478 | ..... | 104.966 | ..... |
| July | 24.978 | ..... | 111.478 | ..... |
| August | 25.738 | ..... | 114.875 | ..... |
| September | 24.618 | ..... | 117.813 | ..... |
| October | 22.723 | ..... | 126.932 | ..... |
| November | 22.779 | ..... | 132.857 | ..... |
| December | 21.328 | ..... | 138.909 | ..... |
| Year | 24.467 | ..... | 118.375 | ..... |

New York quotations, cents per pound. London, pounds sterling per long ton.

## Zinc

| | St. Louis | | London | | | |
|---|---|---|---|---|---|---|
| | 1931 | 1932 | 1931 Spot | 1931 3 Mos. | 1932 Spot | 1932 3 Mos |
| January | 4.035 | 3.011 | 12.747 | 13.113 | 14.416 | 14.834 |
| February | 4.012 | 2.817 | 12.303 | 12.694 | 13.872 | 14.289 |
| March | 4.002 | 2.787 | 12.190 | 12.676 | 12.616 | 13.024 |
| April | 3.717 | ..... | 11.353 | 11.838 | ..... | ..... |
| May | 3.306 | ..... | 10.484 | 10.875 | ..... | ..... |
| June | 3.416 | ..... | 11.270 | 11.750 | ..... | ..... |
| July | 3.893 | ..... | 12.280 | 12.802 | ..... | ..... |
| August | 3.817 | ..... | 11.444 | 12.028 | ..... | ..... |
| September | 3.744 | ..... | 11.571 | 12.063 | ..... | ..... |
| October | 3.377 | ..... | 12.733 | 13.216 | ..... | ..... |
| November | 3.209 | ..... | 13.845 | 14.247 | ..... | ..... |
| December | 3.149 | ..... | 14.361 | 14.818 | ..... | ..... |
| Year | 3.640 | ..... | 12.215 | 12.677 | ..... | ..... |

St. Louis quotations, cents per pound. London, pounds sterling per long ton.

## Cadmium and Aluminum

| | Cadmium | | Aluminum | |
|---|---|---|---|---|
| | 1931 | 1932 | 1931 | 1932 |
| January | 67.115 | 55.000 | 23.300 | 23.300 |
| February | 55.000 | 55.000 | 23.300 | 23.300 |
| March | 55.000 | 55.000 | 23.300 | 23.300 |
| April | 55.000 | ..... | 23.300 | ..... |
| May | 55.000 | ..... | 23.300 | ..... |
| June | 55.000 | ..... | 23.300 | ..... |
| July | 55.000 | ..... | 23.300 | ..... |
| August | 55.000 | ..... | 23.300 | ..... |
| September | 55.000 | ..... | 23.300 | ..... |
| October | 55.000 | ..... | 23.300 | ..... |
| November | 55.000 | ..... | 23.300 | ..... |
| December | 55.000 | ..... | 23.300 | ..... |
| Year | 56.010 | ..... | 23.300 | ..... |

Aluminum in cents per pound, 99 per cent grade.
Cadmium, cents per pound.

## Antimony, Quicksilver, and Platinum

| | Antimony (a) New York | | Quicksilver (b) New York | | Platinum (c) New York | |
|---|---|---|---|---|---|---|
| | 1931 | 1932 | 1931 | 1932 | 1931 | 1932 |
| January | 7.317 | 5.976 | 103.000 | 64.900 | 36.000 | 40.000 |
| February | 7.069 | 6.489 | 100.205 | 66.304 | 34.000 | 40.000 |
| March | 7.127 | 6.188 | 100.423 | 72.537 | 29.538 | 40.000 |
| April | 6.888 | ..... | 102.077 | ..... | 26.346 | ..... |
| May | 6.524 | ..... | 101.140 | ..... | 24.980 | ..... |
| June | 6.342 | ..... | 92.058 | ..... | 37.115 | ..... |
| July | 6.802 | ..... | 85.808 | ..... | 40.000 | ..... |
| August | 6.596 | ..... | 80.115 | ..... | 40.000 | ..... |
| September | 6.542 | ..... | 76.300 | ..... | 40.000 | ..... |
| October | 6.517 | ..... | 72.385 | ..... | 40.000 | ..... |
| November | 6.679 | ..... | 68.587 | ..... | 40.000 | ..... |
| December | 6.231 | ..... | 66.115 | ..... | 40.000 | ..... |
| Year | 6.720 | ..... | 87.351 | ..... | 35.665 | ..... |

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lb. (c) Platinum in dollars per ounce troy.

## Pig Iron[1]

| | Bessemer | | Basic | | No. 2 Foundry | |
|---|---|---|---|---|---|---|
| | 1931 | 1932 | 1931 | 1932 | 1931 | 1932 |
| January | 17.50 | 16.00 | 17.00 | 15.00 | 17.00 | 15.50 |
| February | 17.29 | 15.68 | 16.79 | 14.68 | 16.79 | 15.18 |
| March | 17.00 | 15.50 | 16.50 | 14.50 | 16.50 | 15.00 |
| April | 17.00 | ..... | 16.50 | ..... | 16.50 | ..... |
| May | 17.00 | ..... | 16.38 | ..... | 16.44 | ..... |
| June | 17.00 | ..... | 15.50 | ..... | 16.00 | ..... |
| July | 17.00 | ..... | 15.50 | ..... | 16.00 | ..... |
| August | 17.00 | ..... | 15.50 | ..... | 16.00 | ..... |
| September | 17.00 | ..... | 15.50 | ..... | 16.00 | ..... |
| October | 16.92 | ..... | 15.42 | ..... | 16.00 | ..... |
| November | 16.50 | ..... | 15.00 | ..... | 16.00 | ..... |
| December | 16.25 | ..... | 15.00 | ..... | 15.75 | ..... |
| Year | 16.96 | ..... | 15.88 | ..... | 16.25 | ..... |

Iron in dollars per long ton. [1]F.o.b. Mahoning and Shenango Valley furnaces; freight to Pittsburgh, $1.76.

# Mining Share Prices—Month of March, 1932

| Company Name | High | Low | Last | §Most Recent Dividend |
|---|---|---|---|---|
| **NEW YORK STOCK EXCHANGE** | | | | |
| Alaska Juneau | 16⅜ | 13⅜ | 16¼ | Ap. 9, My. 1 1932....Q 0.12½ |
| American Metal | 5.12½ | 3.50 | 3.50 | December, 1930....Q 0.25 |
| Am. Metal, pfd. | 19 | 14½ | 14½ | Au. 22, Se. 1, 1931....Q 1.50 |
| Am. Sm. & Ref. | 16⅜ | 9.50 | 9.75 | Ja. 15, Fe. 1, 1932....Q 0.12½ |
| Am. Sm. & Ref. 2a pfd. | 50⅜ | 32 | 35½ | Fe. 5, Mh. 1, 1932....Q 1.50 |
| Am.Sm. & Ref. 1st pfd. | 70½ | 50⅜ | 50⅜ | Fe. 5, Mh. 1, 1932....Q 1.75 |
| Am. Zinc, L. & S. | 2.75 | 2.00 | 2.25 | May, 1917.... 1.00 |
| Am. Zinc, L. & S., pfd. | 23 | 20 | 23 | October, 1930....Q 1.50½ |
| Anaconda | 10⅜ | 5.75 | 5.87½ | Jy. 11, Au. 17, 1931....Q 0.37½ |
| Andes Copper | 4.50 | 4.37½ | 4.37½ | Ja. 10, Fe. 9, 1931....Q 0.25 |
| Butte C. & Z. | 1.12½ | 0.87½ | 0.87½ | December, 1929.... 0.50 |
| Butte & Superior | 0.87½ | 0.75 | 0.75 | December, 1929....Q 0.50 |
| Callahan Zinc-Lead | 0.25 | 0.25 | 0.25 | December, 1920.... 0.50 |
| Cal. & Hecla | 3.12½ | 2.00 | 2.12½ | June, 1930.... 0.50 |
| Cerro de Pasco Copper | 13⅜ | 7.00 | 7.50 | Ja. 14, Fe. 1, 1932....Q 0.25 |
| Dome Mines | 11⅜ | 9.25 | 9.62½ | Mh. 31, Ap. 20, 1932....Q 0.25 |
| Federal M. & S. | 25 | 21 | 22 | June, 1927.... 10.00 |
| Federal M. & S., pfd. | ..... | ..... | 36* | My. 25, Je. 5, 1931....Q 1.75 |
| Freeport Texas | 19⅜ | 16 | 16 | Fe. 15, Mh. 1, 1932....Q 0.50 |
| Granby Con | 7.00 | 4.00 | 4.00 | Ja. 15, Fe. 1, 1932....Q 0.12½ |
| Greene Cananea | 13½ | 12 | 12 | July, 1930.... 0.75 |
| Homestake | 1.28½ | 1.16 | 1.23½ | Mh. 20, Mh. 25, 1932...M 0.65 |
| Howe Sound | 13⅜ | 9.00 | 9.00 | Mh. 31, Ap. 15, 1932.... 0.25 |
| Inspiration | 3.25 | 2.12½ | 2.25 | July, 1930.... 0.50 |
| International Nickel | 9.25 | 7.00 | 7.00 | De. 1, De. 31, 1931....Q 0.05 |
| Int. Nickel, pfd. | 86 | 83 | 86 | Ap. 2, My. 1, 1932....Q 1.75 |
| Kennecott Copper | 11⅛ | 6.62½ | 6.75 | De. 17, Ja. 2, 1932....Q 0.12½ |
| McIntyre Porcupine | 16⅛ | 14⅛ | 15⅛ | Fe. 1, Mh. 1, 1932....Q 0.25 |
| Magma Copper | 7.50 | 5.00 | 5.00 | Mh. 31, Ap. 15, 1932....Q 0.12½ |
| Miami Copper | 3.50 | 2.50 | 2.50 | August, 1930.... 0.375 |
| Mother Lode | 0.37½ | 0.25 | 0.25 | June, 1930.... 0.10 |
| National Lead | 92 | 80 | 80 | Mh. 18, Mh. 31, 1932..Q 1.25 |
| National Lead, pfd. A. | 1.25 | 1.16 | 1.16 | Ja. 15, Fe. 1, 1932....Q 0.62½ |
| National Lead, pfd. B. | 1.01½ | 99 | 99 | Ap. 22, My. 2, 1932....Q 1.50 |
| Nevada Con. | 4.87½ | 3.00 | 3.00 | De. 17, De. 31, 1931....Q 0.10 |
| Noranda Mines | 17⅞ | 14 | 15⅛ | De. 15, De. 29, 1931.... 0.50 |
| Park Utah Con. | 1.25 | 1.00 | 1.00 | July, 1929....Q 0.20 |
| Patino M. & E. | 8.12½ | 5.00 | 5.00 | December, 1929.... 4s. |
| Phelps Dodge | 7.00 | 5.12½ | 5.12½ | Je. 18, Jy. 1, 1931....Q 0.25 |
| Rand Mines | ..... | ..... | 20* | August, 1930.... 1.52 |
| St. Joseph Lead | 10⅛ | 6.62½ | 7.00 | Mh. 10, Mh. 21, 1932...Q 0.15 |
| Seneca Copper | 0.25 | 0.25 | 0.25 | ..... |
| Tennessee Corp | 2.62½ | 1.75 | 1.75 | Fe. 28, Mh. 16, 1931....Q 0.125 |
| Texas Gulf Sulphur | 26⅛ | 20⅛ | 20⅛ | Mh. 1, Mh. 15, 1932...Q 0.50 |
| U. S. S. R. & M. | 19⅛ | 15⅛ | 15⅛ | Ap. 4, Ap. 15, 1932....Q 0.25 |
| U. S. S. R. & M., pfd. | 39 | 37⅛ | 38⅛ | Ap. 4, Ap. 15, 1932....Q 0.87½ |
| Utah Copper | 41⅛ | 40 | 40 | De. 17, De. 31, 1931....Q 1.00 |
| Vanadium Corp. | 18⅜ | 10⅛ | 11 | Fe. 2, Fe. 16, 1931....Q 0.75 |
| **NEW YORK CURB EXCHANGE** | | | | |
| Aluminum Co. of Am. | 53⅜ | 33⅛ | 33⅛ | ..... |
| Alum. Co. of Am., pfd. | 60 | 49⅛ | 51⅛ | Ap. 1, 1932....Q 0.75 |
| Anglo-Chilean Con. | 0.50 | 0.25 | 0.25 | 4 shares Cosach B...June, 1931 |
| Bunker H. & S. | 22⅜ | 19 | 19⅛ | De. 31, Ja. 5, 1932....Q 1.50 |
| Carnegie Metals | 1.25 | 1.12½ | 1.25 | ..... |
| Comstock Tunnel | 0.50 | 0.37½ | 0.50 | ..... |
| Con. Coppermines | 0.87½ | 0.62½ | 0.62½ | ..... |
| Copper Range | ..... | ..... | 2* | July, 1930.... 0.25 |
| Cresson Consolidated | 0.25 | 0.18¾ | 0.18¾ | Je. 30, Jy. 10, 1931....Q 0.01 |
| Cusi Mexicana | 0.31½ | 0.25 | 0.25 | ..... |
| Evans-Wallower | 0.37½ | 0.25 | 0.25 | ..... |
| Federated Metals | 5.50 | 5.50 | 5.50 | Ja. 5, Ja. 15, 1931....Q 0.25 |
| Hecla Mining | 4.00 | 2.75 | 3.12½ | Fe. 15, Mh. 15, 1932...Q 0.10 |
| Hollinger Consolidated | 4.62½ | 4.37½ | 4.37½ | Ap. 7, Ap. 21, 1932....M0.05 |
| Hudson Bay M. & S. | 2.37½ | 1.75 | 1.75 | ..... |
| Iron Cap Copper | ..... | ..... | 0.62½* | ..... |
| Mayflower Associates | 26 | 24 | 24⅛ | Mh. 1, Mh. 15, 1932...Q 0.50 |
| Mining Corporation | 1.12½ | 1.12½ | 1.12½ | December, 1929.... 0.12½ |
| New Jersey Zinc | 26⅜ | 24⅜ | 24⅛ | Ap. 20, My. 10, 1932...Q 0.50 |
| Newmont Mining | 13½ | 9.00 | 9.50 | Mh. 31, Ap. 15, 1931..Q 1.00 |
| N. Y. & Honduras Ros. | 14⅛ | 14⅛ | 14⅛ | Ja. 19, Ja. 30, 1932....X 0.37½ |
| Nipissing | 1.25 | 0.62½ | 0.75 | Mh. 31, Ap. 20, 1931..Q 0.075 |
| Ohio Copper | 0.12½ | 0.06½ | 0.06½ | September, 1926.... 0.03 |
| Premier Gold | 0.56½ | 0.43¾ | 0.43¾ | Mh. 14, Ap. 4, 1932.... Q0.03 |
| Quincy | 2.00 | 2.00 | 2.00 | March, 1920.... 1.00 |
| Shattuck Denn | 1.87½ | 1.50 | 1.50 | ..... |
| So. Am. Gold & Plat. | 0.75 | 0.62½ | 0.75 | ..... |
| Teck-Hughes | 4.37½ | 3.75 | 4.00 | Ap. 15, My. 1, 1932....Q 0.15 |
| Tonopah Mining | 0.25 | 0.25 | 0.25 | October, 1929.... 0.07½ |
| United Eastern | ..... | ..... | *0.06½ | ..... |
| United Verde Ex. | 3.62½ | 2.87½ | 2.87½ | Ap. 2, My. 2, 1932....Q 0.12½ |
| Utah-Apex | 0.50 | 0.43½ | 0.50 | December, 1929.... 0.02 |
| Yukon Gold | 0.12½ | 0.12½ | 0.12½ | June, 1918.... 0.02 |
| **BOSTON STOCK EXCHANGE** | | | | |
| Isle Royale | 1.50 | 1.25 | 1.25 | March, 1930.... 0.50 |
| Mohawk Mining | 17½ | 15½ | 17½ | Ap. 2, My. 2, 1932....Q 0.12½ |
| Old Dominion | 1.00 | 1.00 | 1.00 | December, 1918.... 1.00 |
| Utah Met. & Tunnel | 0.41 | 0.35 | 0.35 | December, 1927.... 0.30 |
| **¶MONTREAL** | | | | |
| Asbestos Corp. | 0.20 | 0.15 | 0.20 | January, 1926.... 1.50 |
| Asbestos Corp., pfd. | 1.00 | 0.60 | 0.60 | January, 1930.... 1.75 |
| Consolidated M. & S. | 0.74 | 0.61 | 0.61 | De. 23, Ja. 15, 1932.SAX 1.25 |

| Company Name | High | Low | Last | §Most Recent Dividend |
|---|---|---|---|---|
| **SPOKANE** | | | | |
| Constitution | ..... | ..... | 0.06¾* | ..... |
| Dayrock | ..... | ..... | 0.95* | March, 1930.... 0.03 |
| Golconda | 0.18 | 0.17½ | 0.17½ | July, 1929.... 0.02 |
| Jack Waite Con. | 0.17½ | 0.13 | 0.13 | ..... |
| Los Lugos | ..... | ..... | 0.01½* | ..... |
| Mexican Premier | 0.04½ | 0.03 | 0.04½ | January, 1930.... 0.01 |
| Montana Mines | ..... | ..... | 0.09* | ..... |
| Noble Five | ..... | ..... | 0.03* | January, 1930.... 0.005 |
| Pend Oreille | 1.04 | 0.80 | 0.80 | ..... |
| Sherman Lead | 0.25 | 0.25 | 0.25 | March, 1930.... 0.01 |
| Sidney | ..... | ..... | 0.05* | October, 1929.... 0.01 |
| Sunshine Mining | 1.10 | 1.00 | 1.08 | Mh. 10, Mh. 21, 1932.... 0.02 |
| Tamarack & Custer | 0.14 | 0.13½ | 0.13½ | September, 1924.... 0.25 |
| **SALT LAKE CITY** | | | | |
| Chief Con. | 31 | 28 | 28½ | February, 1928.... 0.10 |
| Combined Metals | 4.75 | 4.25 | 4.50 | ..... |
| Eureka Bullion | 18½ | 6 | 6½ | ..... |
| Eureka Lilly | 6½ | 4½ | 6 | ..... |
| Moscow Silver | 50 | 40 | 40 | ..... |
| New Quincy | 2.50 | 1.00 | 2.00 | September, 1929....Q 0.10 |
| North Lily | 64 | 32 | 52 | January, 1930.... 0.15 |
| Park Bingham | 1.25 | 1.00 | 1.00 | ..... |
| Park City Con. | 12 | 8.50 | 9.50 | ..... |
| Rico Argentine | 3⅜ | 3 | 3 | December, 1929.... 0.03 |
| Silver King Coalition | 3.02½ | 2.85 | 2.85 | De. 20, Ja. 2, 1931....Q 0.15 |
| Tintic Lead | 99 | 95 | 95 | ..... |
| Tintic Standard | 2.37½ | 2.10 | 2.20 | Mh. 7, Mh. 31 1932.... Q0.05 |
| Walker Mining | 46 | 42 | 42 | April, 1930.... 0.075 |
| **¶ TORONTO** | | | | |
| Abana Mines | 0.05 | 0.04 | 0.04 | ..... |
| Amulet Mines | 0.16½ | 0.14½ | 0.15 | ..... |
| Barry-Hollinger | 0.10 | 0.05½ | 0.07½ | ..... |
| Base Metals | 0.85 | 0.75 | 0.80 | ..... |
| Canam Metals | 0.03 | 0.03 | 0.03 | ..... |
| Castle-Trethewey | 0.14 | 0.12 | 0.13 | ..... |
| Central Manitoba | 0.07½ | 0.05 | 0.06 | ..... |
| Falconbridge | 0.90 | 0.80 | 0.80 | ..... |
| Granada Gold | 1.14 | 1.00 | 1.09 | ..... |
| Howey Mines | 0.34 | 0.30 | 0.32 | ..... |
| Keeley | 0.23 | 0.15 | 0.20 | March, 1928.... 0.04 |
| Kirkland Lake | 0.48 | 0.41 | 0.42½ | ..... |
| Lake Shore | 29.50 | 27.20 | 29.25 | Mh. 1, Mh. 15, 1932...Q 0.50 |
| Sherritt Gordon | 0.53 | 0.43 | 0.45 | ..... |
| Siscoe Gold | 0.70 | 0.59 | 0.65 | Mh. 21, Mh. 31, 1932..I 0.04 |
| Sylvanite | 0.60 | 0.52 | 0.53 | De. 5, De. 31, 1931...SA 0.02 |
| Treadwell Yukon | 2.50 | 1.25 | 2.40 | ..... |
| Ventures | 0.45 | 0.40½ | 0.42 | ..... |
| Vipond Con | 0.37 | 0.30 | 0.33 | April, 1927.... 0.03 |
| Waite-A.-M. | 0.82 | 0.50 | 0.56 | ..... |
| Wright-Hargreaves | 2.80 | 2.55 | 1.70 | Mh. 10, Ap. 1, 1932....Q 0.02½ |
| **ST. LOUIS, CINCINNATI, AND DENVER** | | | | |
| Consolidated L. & Z. | ..... | ..... | 1.00* | December, 1929.... 0.125 |
| Eagle-Picher | 4.50 | 4.00 | 4.00 | April, 1930.... 0.20 |
| Eagle-Picher, pfd. | ..... | ..... | 89* | De. 31, Ja. 15, 1931....Q 1.50 |
| Empire Chief | 0.01½ | 0.00½ | (a) | ..... |
| Star of Utah | 0.18 | 0.07 | (a) | ..... |
| Tungsten Prod. | 0.07 | 0.03 | (a) | ..... |
| Ute Gold | 0.06 | 0.03 | (a) | ..... |
| **SAN FRANCISCO, LOS ANGELES, AND COLORADO SPRINGS** | | | | |
| California Copper | 0.50 | 0.25 | 0.37½ | ..... |
| (a) Golden Cycle | 1.00 | 10.00 | 10.50 | Fe. 29, Mh. 10, 1932...Q 0.40 |
| (a) Granite Gold | 0.18 | 0.15 | 0.18 | Mh. 23, Ap. 2, 1932....Q 0.01 |
| Idaho-Maryland | 2.40 | 1.86 | 2.05 | ..... |
| Tom Reed | 0.27 | 0.18½ | 0.18½ | De. 15, Ja. 1, 1932....Q 0.03 |
| (a) United Gold | 0.05 | 0.03½ | 0.05 | Oct. 15, No. 1, 1931....0.01 |

**‡LONDON**

| Company Name | High | Low | Last | Most Recent Dividend (Per Cent, Unless Noted) |
|---|---|---|---|---|
| Anglo American | 8/9 | 6– | 6/9 | 22½, Feb. 19, 1930 |
| Aramayo Mines | 15/– | 11/10½ | 12/6 | 5, Oct. 23, 1929 |
| Burma Corporation | 9/10½ | 8/6 | 8/9 | 1½, Dec. 10, 1930(b) |
| Camp Bird | –/6d | –/4d | –/4d | 16¾, April 25, 1928 |
| Fresnillo | 7/6 | 7/6 | 7/6 | 25 cents, Feb. 12, 1930 |
| Frontino & Bolivia | 16/4½ | 15/9 | 16/3 | 2½, July 1, 1931 |
| Lake View & Star | 10/9 | 8/7½ | 9/6 | 11½, 1921 |
| Mexican Corporation | 3/10½ | 3/– | 3/9 | 10, Oct. 24, 1929 |
| Oroville Dredging | 5/3 | 3/3 | 4/9 | 37½, May 16, 1930 |
| Rhodes.-Select. Trust | 80/– | 55/– | 57/6 | ..... |
| Rhokana Corp. | 6/10½ | 5/– | 5/9 | ..... |
| Rio Tinto | 21⅛ | 13½ | 13½ | 10s, May 1, 1931 |
| St. John del Rey | 18/6 | 17/1 | 18/– | 9d, No. 20, 1931 |
| San Francisco Mines | 9/3 | 8/– | 8/6 | 10, Jan. 7, 1931 |
| Santa Gertrudis | 6/7½ | 5/9 | 6/– | 9d., July 9, 1931 |
| Selukwe | 1/10 | 1/3½ | 1/9 | 6¼, April 2, 1917 |
| So. American Copper | –/6d | –/3½d | –/4½d | ..... |
| Tanganyika | 27/9 | 18/4½ | 18/9 | 2½, Aug. 2, 1930 |
| Wiluna Gold | 15/10½ | 12/1½ | 14/6 | ..... |
| Union Minière | 4,290 | 3,695 | 3,695 | 240 francs, July, 1931 |

Salt Lake Stock Exchange courtesy J. A. Hogle & Company. ¶These figures are quoted in Canadian dollars. *Not traded in. †Belgian francs. ‡The above London quotations are for the month ended Feb. 23. Q, quarterly; I, initial; M, monthly; X, extra; SA, semi-annual; L, liquidating B, plus bonus. §Total dividends paid during the month will be found tabulated in the Market and Financial News Section. Dates here given are those of closing of books and payment of dividend. (a) Bid prices. (b) 1⅛% (2 annas) dividend, and bonus of ⅛% (1 anna). (c) Closing bid prices. F.W., four weeks.